

# SCIENCE

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## THE CHARACTERIZATION AND CLASSIFICATION OF BACTERIAL TYPES<sup>1</sup>

THE vast majority of students of microbial life are preoccupied with immediately practical problems, and most of them have been trained for their work from the standpoint of some practical art, medicine, veterinary science, sanitary engineering or agriculture, rather than from the more general and fundamental standpoint of the biologist. The Society of American Bacteriologists was founded as a protest against such necessary but dangerous specialization, to bring together workers in all fields for a consideration of their problems in the light of the underlying, unifying principles of bacteriology as a member of the group of the biologic sciences. It is this ideal which distinguishes our society from any other organization in America which deals with microbic life and its effects.

It is of course fruitless to attempt to draw any sharp distinction between pure and applied science, and it would be a great pity if, as we gather year by year, we should fail to discuss together many of the more special problems of technique with which we are concerned. In particular it is well that we should exercise the widest hospitality toward those branches of our science, such as dairy bacteriology and soil bacteriology which have no technical societies at their disposal, such as are available for the specialists in medical and sanitary lines. We should be untrue to our highest mission, however, if we failed at the same time to emphasize those phases of our work in which this society of all others

<sup>1</sup> Presidential address, Society of American Bacteriologists, Montreal, Canada, January 1, 1914.

is peculiarly qualified to be of service, in striking sparks by the contact of experience in the different fields of bacteriology, and in viewing all our special problems by the clear light of fundamental biological principles.

The task of the biologist is the study of the reactions of the group of allied substances we call protoplasts, under the influence of various physical and chemical conditions of the environment. Instead of the pure compounds of the chemist we must deal with organisms, interacting mixtures of substances, different for each kind and even for each individual plant and animal. In very refined work such as is involved in the determination of reaction times by the psychologist or in our own studies of the action of disinfectants, even the personal equation of the individual or the individual strain must be taken into account. For most purposes, however, the species or kind of organism displays reasonably uniform characteristics, and may be used as our practical unit of study. A clear distinction between the kinds of organisms involved and a clear conception of the relation between these kinds is certainly however imperative, and a sound basis for the characterization and classification of the organisms with which we deal is one of the most pressing needs of bacteriology.

The fact that we have lacked in the past any sound system of sorting out and arranging bacterial types requires no elaborate demonstration. The question of what constitutes a colon bacillus has agitated sanitary bacteriologists for three decades and is still unsolved. And to take a still more striking and still more important case, consider the controversy as to the *Vielheit* or the *Einheit* of the streptococci, which has raged so long. Here is a group of organisms, the part played by which in a wide range of diverse diseases is found to be more fundamental—a group which I am

inclined to think produces in the aggregate more suffering and death—than any other group, except the acid-fast bacilli. Yet we are almost wholly at sea in regard to their identification and mutual relationships.

There are two very distinct types of variations characteristic of organisms in general, fluctuations and mutations, and both are well recognized among bacteria. Fluctuations are the minor quantitative differences which group themselves on a curve of frequency when a large series of individuals is studied, as a rule due to the chance effects of environment and not inheritable. Thus, for example, Walker and I (Winslow and Walker, 1909) found that one hundred different subcultures of a single strain of the paratyphoid bacillus race *A* gave acidities in dextrose broth varying between 1.1 and 1.6 per cent. normal, while a similar series of lines of race *B* gave acidities varying between 1.3 and 1.9 per cent. normal. We took the subcultures of each type giving maximum and minimum acidities and isolated one hundred secondary subcultures of each. The curves from these extreme cultures however in spite of the diversity exhibited by their immediate parent stock, went back to the curves characteristic of their respective races, with a mean value of 1.4 for race *A* and of 1.6 for race *B* (Fig. 1). These fluctuating variations are clearly of no systematic significance and must be eliminated from consideration by a study of numerous strains of the same type.

It seems on the whole most convenient to limit the term fluctuations to such non-inheritable variations as those just described. At times, however, we find in our cultures variations of apparently similar nature, but distinguished by the fact that selection among them does produce permanently different races. Thus, Goodman (1908) carried out experiments with the acid production of *B. diphtheriae* somewhat

like those with the paratyphoid strains which have just been discussed, but leading to the ultimate separation of two strains of widely different fermentative power. Rettger and Sherrick (1911) report similar results in regard to the pig-

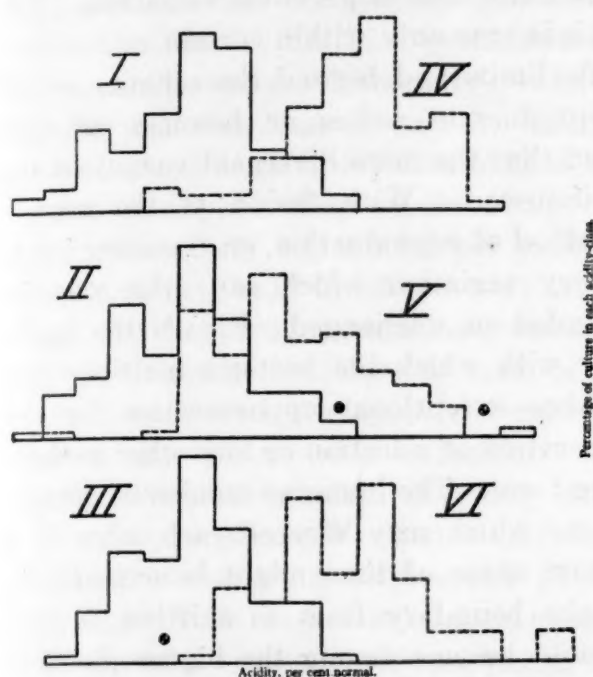


FIG. 1. ACID PRODUCTION BY PARATYPHOID BACILLI. (I.) Distribution of 100 original cultures, Type A. (II.) Distribution of 100 subcultures of descendants of maximum strain, Type A. (III.) Distribution of 100 subcultures of descendants of minimum strain, Type A. (IV.) Distribution of 100 original cultures, Type B. (V.) Distribution of 100 subcultures of descendants of maximum strain, Type B. (VI.) Distribution of 100 subcultures of descendants of minimum strain, Type B.

ment-producing power of some of the red chromogens and the resistance to mercuric chlorid of the *Aurococcus*; and in their paper the similar results of earlier observers are discussed. Such variations as these strongly suggest the pure lines of Johannsen and may perhaps for convenience be designated as pure line variations.

A distinct type of variation is the mutation, a definite sharp variation separated by a wide gap from the normal character of the type, arising spontaneously in

a certain regular proportion of the individuals of a race. Barber (1907) has shown for example that peculiar filamentous chains of cells occur, rarely, but with considerable regularity, in cultures of *B. coli*, and that by isolating these filaments and breeding from them he could get a new race, constantly showing the filamentous arrangement and possessing definite cultural characters and a fermentative power considerably higher than the normal. Similar, though less conclusive results were obtained with *B. typhi*, and in one case an apparently non-spore-forming race was derived from *B. megatherium*. A particularly interesting case is that of the fermenting mutants of the typhoid group first observed by Neisser and Massini and recently thoroughly worked out by Penfold (1912). With a number of different strains of typhoid and paratyphoid bacilli and a number of different sugar media it has been shown that an organism which does not ferment the carbohydrate in question may produce on media containing it colonies which after several days bear curious raised papillæ. Subcultures from these papillæ yield a pure culture of a strain which resembles the parent stock in every respect, except that it actively ferments the specific carbohydrate and forms no papillæ; and this mutant breeds true. On the other hand subcultures from other parts of the parent colony produce strains which, like the original stock, do not ferment en masse, but do possess the property of throwing off fermenting mutants. Clark (1913) has recently shown that some at least of these modifications may have been quantitative only rather than qualitative, but the sharpness of the difference involved seems to warrant their recognition as true mutations.

Either fluctuations or mutations may originate as a result of protoplasmic in-

equalities in cell division and without any corresponding variations in environmental condition. Or, on the other hand, they may be causally related to changes in the chemical and physical surroundings of the organism as were those which MacDougal produced among the higher plants by injecting chemicals into the ovary and such as Tower caused by exposing potato beetles to special conditions of temperature and humidity. Changes of this sort are very familiar among the bacteria, as for example in the case of the increase in virulence on passage through susceptible animals, or the converse process of attenuation, as practised in the preparation of vaccines for anthrax and other diseases. Wolf (1909) reports a considerable number of temporary modifications and some permanently inheritable ones stimulated by exposing bacteria to the action of chemicals. White and dark red strains were thus produced from a normal *B. prodigiosus*, the resulting modifications breeding in each case true to their new type. Variations of this sort called forth by the direct effect of the environment I have been accustomed to distinguish by the term "impressed variations."

The net result of the various sorts of variability to which the bacteria are subject is to produce a condition, not different in kind, but more extreme in degree, than that which exists among more complex forms. As Bateson (1913) says: "The problem of species in its main features is presented by these organisms in a form identical with that which we know so well among the higher animals and plants." Several peculiar conditions tend, however, to make specific distinctions even more unstable among the bacteria than elsewhere. In the first place the action of the environment upon unicellular organisms is peculiarly direct and the fact that all cells are potentially reproductive removes any bar

against the inheritance of acquired characters. Again the absence of sexual reproduction must operate to preserve variations which arise from within or without. Among sexual organisms it is true that amphimixis is held to be in itself an important source of germinal variations. Yet this is true only within certain rather definite limits and beyond those limits sexual reproduction ceases or becomes infertile and thus the more divergent variations are eliminated. With fission as the normal method of reproduction, on the other hand, every variation which can arise may be handed on, unchanged. Finally the rapidity with which the bacteria multiply furnishes exceptional opportunities for the operation of selection or any other modifying force. The immense number of generations which may succeed each other in a short space of time might be expected to make boundary lines as shifting as they would become among the higher plants if a dozen geological epochs were considered all at once.

There are sharp limits to the variability of even the bacteria however and for practical purposes we find the larger groups quite constant in their general properties. As a rule typhoid germs descend from typhoid germs and tubercle bacilli from tubercle bacilli. The same yellow coccus falls on gelatin plates exposed to the air, all over the world. The same spore-forming aerobes occur in every soil, the same colon bacilli crowd the intestines of animals and men in every clime. In part at least I am inclined to believe that this is due to the direct or selective effect of similar environmental conditions producing what Jordan and Kellogg call among higher organisms "Ontogenetic species held for a number of generations true to a type simply because the environment, the extrinsic factors in the development of all the individuals in these successive generations, are

the same." The comparative fixity of the more strictly pathogenic bacteria is a striking illustration of this tendency.

In many instances we find that individual strains of bacteria exhibit an extraordinary uniformity in minor characteristics even when (or perhaps particularly when) cultivated for long periods on artificial media in the laboratory. The two paratyphoid strains, *A* and *B*, described above offer a striking instance of this. The mean acid production of the two strains was respectively 1.4 and 1.6 per cent. normal, differing only by .2 per cent. normal and the fluctuating variations, extending over a range of over 1.0 per cent. in each case, far exceed the mean difference between the strains. Yet subcultures show each strain, as a strain, breeding true to its characteristic. We find slight differences in resistance to unfavorable physical condition or to the action of some chemical disinfectant transmitted unchanged in a particular strain for generation after generation.

As a matter of fact indeed it is not alterations in the characters of bacteria while we are studying them which generally trouble us, but the fact that as we isolate these organisms in nature we find that antecedent variations have produced a bewildering confusion of slightly differing varieties or races or strains. Between well-marked types like *B. coli* and *B. alcaligenes* is a series of forms, each one differing but slightly from its neighbor, but together almost completely bridging the gap between the two extremes. The more refined our methods of bio-chemical examination, the more the types are multiplied, and the more hopeless is the confusion. When Gordon (1905) applied his nine tests to 300 different strains of streptococci, he found 48 different combinations of reactions, and MacConkey (1909) records 36 different varieties of colon bacilli characterized by

particular combinations of his seven tests. To call each distinguishable strain having definite bio-chemical properties a species and to give it a name of its own, is quite out of the question. To ignore all minor differences and maintain as specific such complex groups as are included under the term *B. coli* or *Str. pyogenes* is misleading and an effective bar to future progress.

The first principle, which has proved of prime assistance in the characterization of bacterial types, and which offers a rational compromise between either false unity or bewildering multiplicity, is the recognition of the fact that types which occur commonly among bacteria as they are found in nature are of greater systematic importance than those which occur rarely and occasionally. Of course from one standpoint every inheritable protoplasmic variant which exists is of equal importance with every other. For practical purposes, however, we must recognize certain types as "species" or "varieties" even though they may sometimes intergrade. Among the higher plants and animals such systematic units are usually recognized on the basis of discontinuity in some definite character. The more refined methods of biometry have however revealed another grade of kinds (I use this word to avoid the artificial implications of "species" or "variety"), marked by relative rather than absolute discontinuity. Frequently the measurement of some particular differential character and the plotting of a "frequency polygon," with grades of the chosen character as abscissæ and the proportion of individuals showing each grade as ordinates, shows a curve with two distinct peaks, a bimodal curve. The studies reported by Bateson on the length of the cephalic horns of the rhinoceros beetle and on the forceps length of the earwig and De Vries's observations on the petals of a chrysanthemum, are excellent examples.

In each case the peaks on the curve indicate distinct centers of variation around which the intermediate fluctuations are grouped and these constitute biologic facts of real importance, even though the types overlap and appear to blend in the valleys between the modes.

Johannsen in his recent book (1913) has discussed such bimodal curves with admirable clearness and points out that obvious phenotypes (externally recognizable kinds) may or may not represent true genotypes (characterized by germinal differences),—

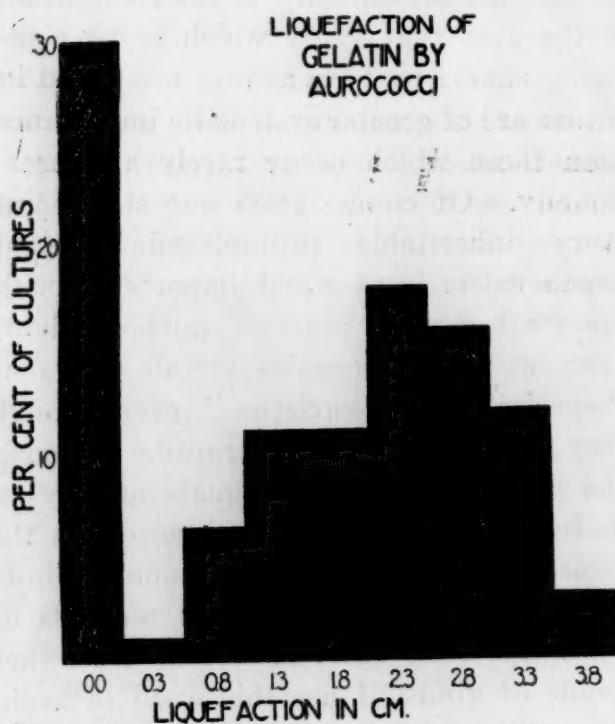


FIG. 2.

breeding experiments being the only final criterion. In our bacteriological work we are making breeding experiments all the time and even though our study of mass reactions may be crude, it is free from the grosser errors due to environmental variations, and our bimodal curves indicate real protoplasmic diversity. For example, in a study of the gelatine liquefying power of the orange cocci, it appeared that the depth of liquefaction after 30 days varied from 0 to over 3.5 cm., each intermediate .5 c.c.

value being represented. Yet the frequency with which various grades of liquefaction occurred showed that only two distinct types were common (Fig. 2), one failing entirely to liquefy, including 30 per cent. of the strains studied, and the other liquefying rapidly, to the extent of 2.0–3.5 cm., including 45 per cent. of the strains. Ordinarily such a difference in proteolytic power as that between a liquefaction of 1.0 cm. and one of 3.0 would be considered important as marking a distinction between a very slowly and a rapidly liquefying type. Yet in view of the frequency curve it is both practically convenient and biologically sound to say that we are dealing with two and only two distinct types, so far as this character is concerned, one not liquefying at all and the other liquefying vigorously to an extent of 2.0–3.5 cm. in 30 days, while slowly liquefying strains may be considered as aberrant varieties.

Another example of this conception of frequency types may be taken from recent studies of the fermentative power of the colon bacilli and the streptococci. Both these groups have been split up according to their acid-producing power in a wide variety of carbohydrate media and any one sugar has been considered just as important as any other, giving almost as many types as there are permutations and combinations of the test substances used. Howe (1912) has shown for the colon bacilli, and the same thing is true for the streptococci (Winslow, 1912), that the various carbohydrate media are not fermented at random, but stand to each other in a definite "order of availability" forming what Howe calls a "metabolic gradient," such that if any member of the series is fermented the chances are that those ahead of it will be fermented also. Thus in the colon group dextrose is most often attacked, then lactose, then saccharose and then raffinose. Certain steps in the gradient are qualita-

tively far more important than others. Of 540 dextrose fermenting bacilli freshly isolated from the intestine Howe found that practically all attacked lactose. Saccharose divided the group into two approximately equal subgroups, 58 per cent. attacking this sugar and 41 per cent. failing to do so. Of the 58 per cent. all but 5 per cent. also attacked raffinose so that the dextrose-lactose-saccharose forms may be considered intermediate variants between the two main di-

good reason to think it deserves special importance. In the same way the admirable study by Stowell, Hilliard and Schlesinger (1915) of the streptococci shows that the five groups fermenting respectively dextrose only, dextrose and lactose, dextrose, lactose and saccharose, dextrose, lactose, saccharose, and raffinose and dextrose, lactose, saccharose, raffinose and salicin are quantitatively of special importance and include between them 68 per cent. of 240 strains studied.

A second conception, of much assistance in the classification of bacteria, is the principle that special weight should be given to characters quantitative or qualitative, which are found to be correlated with each other in a number of different types. The principle of numerical frequency offers a basis for characterizing the individual types and the principle of correlation a basis for classifying these types in accord with their biological relationships.

The early bacteriologists established a dozen genera, such as *Streptococcus*, *Sarcina*, *Bacillus*, *Bacterium*, and the like, based entirely on a few obvious morphological characters. Some of these genera are undoubtedly valid. Others like those which are based only on the presence or absence of flagella are quite as certainly invalid. No one familiar with the colon group can hold that it is reasonable to place the common type of motile colon bacillus in the genus *Bacillus* along with *B. mycoides*, *B. aerogenes*, *B. anthracis*, *B. prodigiosus*, *B. radicumicola* and *B. tetani* and to place an organism having all its other properties identical but lacking flagella in the genus *Bacterium*. The same arguments hold true against the genera *Planococcus* and *Planosarcina* among the cocci. We find in several of the major groups motile and non-motile forms which are precisely alike in half a dozen respects and are clearly minor varieties of the same

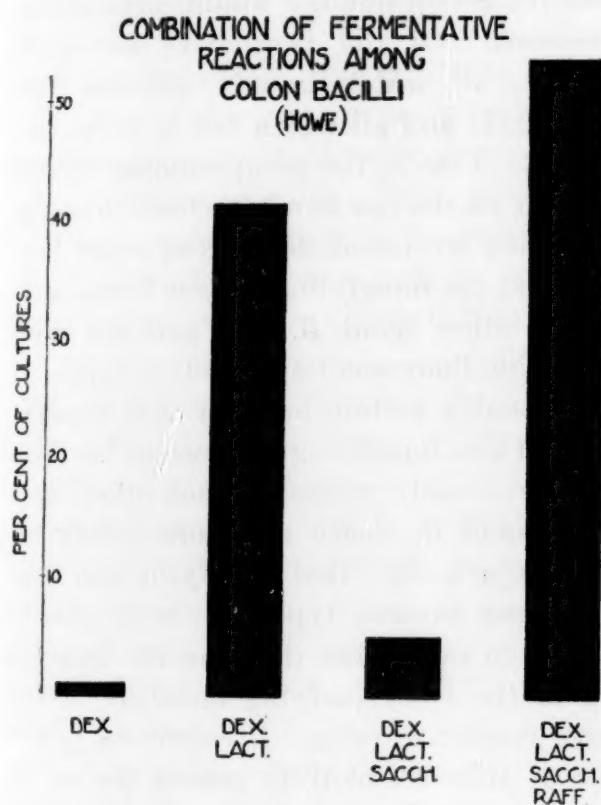


FIG. 3.

visions which ferment either dextrose and lactose alone or all four sugars (Fig. 3). It seems clear that such quantitative studies furnish the surest basis for deciding which sugars are primarily important in classification and we may safely conclude that so far as these four sugars are concerned there are only two important divisions of the colon group. The use of dulcitate which occupies an equally prominent place in the classification of MacConkey (1909) and Jackson (1911), rests on no such biometrical basis and we have no

type, and it is absurd to give them generic rank, and group together widely different types which are alike in no single respect except that they have flagella. These genera based on motility are on a par with a division of animals into those with wings and those without, which would place bats and birds and flying fishes and bees in one group and cats and ordinary fishes and worker ants in another.

The unsatisfactory nature of the Migula classification, which, even if the motility genera were accepted, left over one third of all known bacteria in the genus *Bacillus*, led many bacteriologists to abandon any attempt at a natural classification and to seek refuge in frankly arbitrary schematic groupings. The logical outcome of this tendency is the decimal group number which our society has adopted, the history of which has been so ably presented by Professor Harding (1910).

The group number, according to which the characters of bacteria are indicated by a conventional series of decimals, has an undoubted value and has proved a godsend to workers who study a large series of new cultures and desire a concise record of their behavior. It is a sort of index to the chief characters of the organisms in question, a method of cataloging reactions observed. It is obvious however that it is artificial, and that it does not furnish a "classification," an arrangement of bacteria according to their natural relationships.

There is some danger, I think, that this important distinction between the group number on our standard card and a real biological classification may be forgotten. When the student notes that 100 means that endospores are produced and 200 that they are not produced, he is likely to draw the conscious or subconscious conclusion that all bacteria producing endospores are more closely related to each other, are more

of a kind, than are the members of the two separate groups. I think that this is very probably a fact. Then, of the non-spore formers, he notes that strict aerobes fall under 210, strict anaerobes under 230 and facultative forms under 220. Again he is likely to draw a similar conclusion as to relative relationships and again perhaps the conclusion is reasonably correct. In the third place of the whole numbers, however, any such deduction as to natural relationships from the group number would certainly be erroneous. Of the facultative non-spore formers, all which liquefy gelatine fall under 221; and all which fail to do so under 222. That is, the group number throws together on the one hand *B. cloacæ* and the liquefying strains of fluorescent water bacteria and the liquefying proteus forms, and on the other hand *B. coli* and the non-liquefying fluorescent and proteus types. It is reasonably certain however that liquefying and non-liquefying fluorescent bacteria are more closely related to each other, that *B. coli* and *B. cloacæ* are more closely related to each other, that liquefying and non-liquefying proteus types are more closely related to each other than are the liquefying or the non-liquefying members of the three respective pairs. Precisely as in the case of Migula's motility genera the use of a single arbitrarily chosen character in classification leads to misleading results.

It is sometimes held that the difficulties we experience in bacterial classification are due to the fact that we must necessarily rely in the main on physiological rather than on morphological characteristics. I do not believe this to be the case. There is no fundamental distinction between morphological and physiological properties, since all are at bottom due to chemical differences in germ plasm, whether they happen to manifest themselves in the size and arrangement of parts or in the ability

to utilize a certain food stuff. Indeed biochemical properties have a peculiar and unique significance among the bacteria, since it is precisely along the lines of metabolism that these organisms have attained their most remarkable differentiation. The higher plants and animals have developed complex structural modifications to enable them to obtain food materials of certain limited kinds. On the other hand the bacteria have maintained themselves by acquiring the power of assimilating simple and abundant foods of varied sorts. Evolution has developed gross structure in one case without altering metabolism; it has produced a diverse metabolism in the other case, without altering gross structure. There is as wide a difference in metabolism between the pneumococci and the nitrifying bacteria as there is in structure between a liverwort and an oak. The danger in using physiological characters for classification lies, not in their inherent unreliability, but in the fact that so many physiological properties are directly adaptive in nature. Adaptive characters of similar nature are likely to arise in different groups under the influence of similar environmental conditions and may prove altogether misleading as to true phylogenetic relationships. Professor Gadov in his striking address before the British Association has called the independent evolution of a nearly identical character from homologous material isotely. We have excellent examples among the bacteria. It seems clear for example that we must assume from the presence of liquefying and non-liquefying types among so many of the principal groups of bacteria that this property has lain latent in a great many independent lines of descent and has been independently released in many of them, perhaps by environmental forces. It is particularly to avoid this danger of con-

fusing independently acquired adaptive characters with those which indicate real community of descent that we must lay stress on the significance of a number of independent characters which occur in correlation. If the correlation is due to an essential dependence of one character upon the other it is of course not particularly significant; but, when we find a number of different characters, which have no necessary connection, correlated together, the presumption is warranted that common descent is the connecting link which has united them.

It was in the study of the Coccaceæ that the full importance of emphasis on correlated characters first impressed itself upon me. It had long been the practise, following the Migula system, to group all the staphylococci of the skin and the saprophytic cocci which divide in one and two planes together in the genus *Micrococcus* and to separate the packet-formers in the genus *Sarcina*. The common cocci found on the skin, all liable to assume at times pathogenic properties, were usually classed as merely three color varieties (*aureus*, *albus* and *citreus*) of a single species *Micrococcus* or *Staphylococcus pyogenes*. In the attempt to apply statistical principles to the classification of this group,<sup>1</sup> Mrs. Winslow and I collected and studied 500 different strains of cocci, measuring quantitatively so far as possible eleven different characters of each strain. At once a new and surprising set of relationships manifested themselves. It was evident in the first place that on the whole the cocci living normally on the body surfaces, differed in almost every respect from the cocci

<sup>1</sup> First published in Biological Studies by the Pupils of William Thompson Sedgwick, June, 1906, and in the *Journal of Infectious Diseases* for the same year and later elaborated in our book on the "Systematic Relationships of the Coccaceæ," N. Y., 1908.

of the water and earth. The former usually occurred in chains or small irregular groups, reacted positively to the Gram stain, formed a meager or only fair surface growth on solid media, and produced considerable acid in carbohydrates. The cocci of the water and earth occurred in large cell groups or packets, never in chains, were usually Gram negative, grew abundantly on solid media and generally failed to ferment carbohydrates. There were exceptions of course, as there always must be in an unstable group like the bacteria. Some organisms which a general consideration of all their characters would place in the latter group were found on the skin, while others were Gram positive or fermented the sugars. Yet on the whole the relation seemed a sufficiently definite one to warrant the division of the spherical bacteria into two subfamilies, the Paracoccaceæ and the Metacoccaceæ. The next thing which was apparent was that the color of the pigment produced, instead of being a minor varietal character, was fundamentally correlated with other properties which were apparently of sufficient importance to deserve generic rank. It appeared that the orange and white staphylococci, along with the diplococci and streptococci, all shared the properties of the Paracoccaceæ just enumerated, while the yellow and red pigment formers (in spite of the occasional presence of the former on the skin and even in connection with pathological processes) exhibited the characters of the Metacoccaceæ (Fig. 4). The white and orange forms further differed from each other in the fainter surface growth of the former and in the important fact that liquefying members of the orange series liquefy twice as rapidly as do the liquefying white strains. Hence we distinguished these groups as the genera *Aurococcus* and *Albococcus*. Among the

Metacoccaceæ the yellow and red forms were sharply separated by the much higher proportion of strains which reduce nitrates to nitrites and by the absence of ammonia formation in nitrate pepton broth and by the rarity and slowness of liquefaction, among the red chromogens, for which we

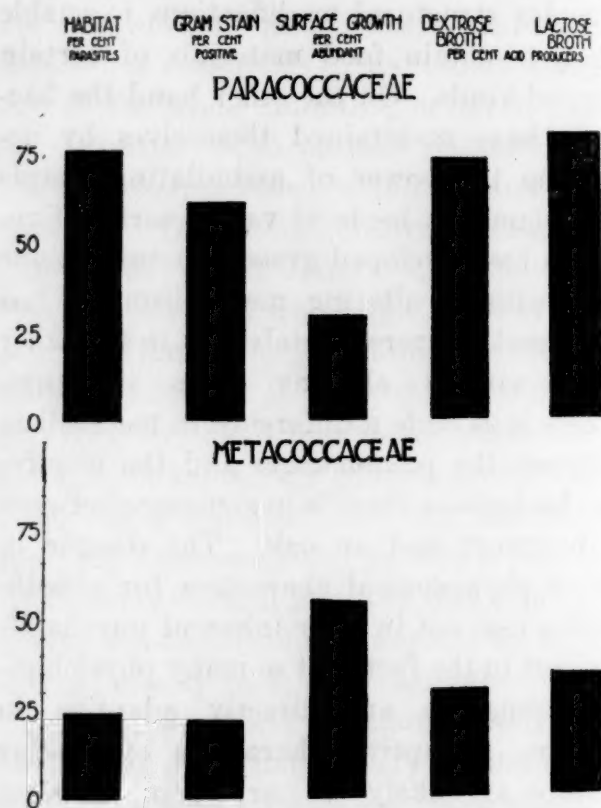


FIG. 4. GROUP DIFFERENCES BETWEEN THE PARACOCCEÆ AND THE METACOCCEÆ. The upper blocks show for 221 strains of cocci whose type of chromogenesis (white or orange) would place them with the parasitic subfamily, the per cent. of strains fulfilling each of five individual criteria of that group. The lower blocks show for 279 strains of cocci whose type of chromogenesis (yellow or red) would place them with the saprophytic subfamily the per cent. of strains fulfilling each of five individual criteria of that group.

suggested the generic name *Rhodococcus*. The important point brought out by these studies was that chromogenesis and the Gram stain, characters which we all had believed to be comparatively unimportant, proved to be correlated with a number of other properties and therefore highly significant. On the other hand the Migula

distinction between *Micrococcus* and *Sarcina* appeared to be of quite minor importance. Among the yellow chromogens we found a completely parallel series of packet-formers and non-packet formers exactly alike in all other respects. So with liquefaction of gelatine. Among aurococci, albococci, micrococci and sarcinae were strains having all other properties in common, but differing in this one respect. Kligler (1913) has recently examined the cocci in the American Museum collection and has found that the fifty strains represented fall very clearly in the genera thus outlined, although he concludes that the species originally described should be modified in certain important respects.

The general principles of statistical classification were outlined as follows by Miss Rogers and myself (1906):

We have first plotted the frequency curve for each character in order to find whether the array varies about one or several modes, and where these modes are situated. . . . In the second place, we have calculated correlation factors for the most significant pairs of characters. Each mode on the curves of frequency may fairly be taken to mark a natural species or variety, and the characters which vary together must form the most important basis for the establishment of the larger groups. By such a method alone it is possible to locate those mountain peaks in the chain of bacterial variations which rightly deserve generic and specific names.

In the same year in which this paper was published, Andrewes and Horder in England presented a revision of the species in the genus *Streptococcus* (1906) based on exactly identical principles at which they had independently arrived. They say:

There was, however, one guide which, as in all such taxonomic problems, proved of the greatest help, namely, the numerical frequency of occurrence of any given type. . . . The common types stand out as mountain tops above their fellows, each mountain connected by valleys of intermediate types with many of its neighbors.

Since these suggestions were first made, the statistical method has been systematically applied by Howe (1912) to the colon group, by Stowell, Hilliard and Schlesinger (1913) to the streptococci, by Dr. Morse (1912) to the diphtheria group and by Rogers and Davis (1912) to the lactic acid groups.

There are many other serious investigations of bacterial relationships which might be cited, many of them made before the term "statistical classification" was thought of in this connection, but characterized by the fact that they include a careful comparative study of many different strains with due regard to the frequency with which types occur and to the special importance of correlated characters. Among the earlier investigations, Beijerinck's study of the acetic acid bacteria (1898), Chester's on the aerobic spore formers (1904) and Hefferan's on the red pigment producers (1904) are worthy of special mention. More recently Edson and Carpenter have given us an excellent revision of the group of fluorescent bacteria (1912). Owen (1911) has added much to our knowledge of the aerobic spore formers, White (1909) has revised the *B. bulgaricus* group and Dr. Claypole (1913) has worked out some very striking correlations between immunity relations and cultural characters among the streptothrices. The elaborate study of the dysentery group by the late Dr. Hiss (1904) and Elser and Huntoon's review of the Gram-negative cocci (1909) should also be mentioned in this connection. There has already been accumulated a considerable mass of data which when critically examined and codified should furnish a good basis for a systematic arrangement of many of the smaller bacterial groups.

So far as the general classification of the bacteria into larger groups, families and

genera, is concerned, we have also, I believe, plenty of information which if properly digested would make it possible to arrive at reasonable and helpful results. With these large groups no special statistical study is generally necessary, for the chief characters of the major types are well established. All that is needed is interpretation, but interpretation based on a view of all the available facts and on a sound conception of biological principles. Until recently the only attempt at a general classification of the bacteria based on a common-sense interpretation of all the characteristics of the organisms is that presented by Flügge (1896), the chief value of which lay in the classification of the rod-shaped bacteria into 22 groups, almost all of which appear to represent natural aggregations of allied types. For example, we all recognize that the aerobic spore formers, the anaerobic spore formers, the colon-typhoid group, the nitrifying organisms, the fluorescent bacteria, and the group of diphtheria and tubercle bacilli constitute real groups of related organisms.

Four years ago a more ambitious attempt at a fundamental analysis of the systematic relationships of the whole group of bacteria was made by Professor Orla Jensen, of the Polytechnicum of Copenhagen (1909). Professor Jensen with good reason discards the purely morphological basis of classification and in particular the distinction based on the presence or absence of flagella. The arrangement of flagella when they are present, on the other hand, offers a convenient index of other more important differences and Professor Jensen gives his two orders of bacteria the names of Cephalotrichinæ (monotrichous or lophotrichous) and Peritrichinæ (peritrichous). The Cephalotrichinæ, deriving their life energy almost entirely from oxidative processes, are all water or

moist earth forms, with the exception of a few peculiar plant and animal parasites and for the most part grow badly or not at all on ordinary organic media, and spores are never formed. The series begins with the Oxydobacteriaceæ, including the most primitive bacteria, which oxidize methane and carbon monoxid, the nitrifiers, the acetic acid bacteria and the Azotobacter group. Then follows the Actinomyces family which includes the root nodule bacteria and the mycobacterium (tuberculosis) group. The collocation of the latter forms is startling at first, but their morphology, their oxygen requirements and their unique pathological relations, almost symbiotic by contrast with the quick toxic action of other pathogenic bacteria, offer some evidence of real relationship. The third, fourth and fifth families are the Thiobacteriaceæ (the sulfur bacteria), the Rhodobacteriaceæ (the red or purple sulfur bacteria) and the Trichobacteriaceæ (*Cladothrix*, *Crenothrix*, *Beggiatoa*, etc.) which are clearly natural groups. The last two families, the Luminibacteriaceæ and the Reducibacteriaceæ, are typically denitrifying organisms which form a connecting link between the primitive oxidizing bacteria and the Peritrichinæ. They include the fluorescent water bacteria and the phosphorescent vibrios and at the higher end of the series such forms as the cholera organism in which the ability to split complex products with the formation of lactic acid and indol begins to appear.

The second order, the Peritrichinæ, includes the more specialized bacteria in whose metabolism the splitting of carbohydrates or amino-acids plays a primary rôle rather than oxidation or denitrification. They are rods or cocci, peritrichous when possessing flagella at all, and among them are found all the commoner putrefactive and parasitic types. This order, according

to Jensen, may be divided into four families. The first, the Acidobacteriaceæ, includes the non-spore-forming carbohydrate fermenting types, among the principal representatives being the colon-typhoid group and practically all the cocci. His second family, the Alkalibacteriaceæ, shows a higher development of the power of decomposing nitrogenous bodies, and includes the liquefying proteus forms, the actively liquefying aerobic spore formers and certain urea fermenters. The last two families, the Butyribacteriaceæ and the Putribacteriaceæ, are made up of the strict anaerobes.

Whatever minor criticisms may be made of Professor Jensen's scheme, I believe that no one who has thought seriously about bacterial relationships can study it carefully without feeling that it is by far the most successful attempt yet made at a real biological classification of the group and that future progress will probably consist in its modification and extension rather than in any profound reversal of its basic principles.

Inertia in terminology is strong and it is the business of no one in particular to criticize and report on the value of suggestions as to bacterial classification and nomenclature. We are all too busy with our own special field to undertake such a task of our own accord. Yet I believe that in the present state of bacteriology such a critical examination of suggested systematic arrangements is most essential. A mass of work has been done in the last ten years, potentially valuable, but almost useless so long as it remains a sealed book to all but its respective authors and their pupils.

What we need at this time is a court of appeal on matters of systematic bacteriology, a court to which all suggested classifications, past and future, may be referred

for official acceptance or rejection, in whole or in part. Such a court or commission might take first Professor Jensen's classification as the most recent comprehensive attempt to treat the whole group of the bacteria, and after careful consideration might adopt such of his families and genera as seem well established and issue a report in which they should be definitely and clearly defined. Such a report from a commission of a proper caliber would not be ignored as work of any single worker may be, but would be adopted and would become at once a part of the practical working machinery of our science. The genera and species suggested for the Coccaceæ, the Andrewes and Horder species of the genus *Streptococcus*, Chester's species of spore-bearing aerobes, Dr. Morse's types of pseudo-diphtheria bacilli, Edson's types of fluorescent bacteria, etc., might be later taken up so that ultimately a complete scheme of bacterial classification would be at our disposal.

Such authoritative commissions on classification and nomenclature are well established in the older biological sciences, as for example, the International Commission on Zoological Nomenclature appointed by the Third International Zoological Congress in 1895 and made permanent at the Fourth Congress in 1898. Its work has been much more along the line of precise legal definitions and the determination of priority in terminology, than would be the case with a similar commission in bacteriology. The broader constructive work which has already been accomplished in zoology still remains for us to do. Furthermore we have no international congress to which such a commission could profitably report on all the phases of its work, although for one group of the bacteria, the colon-typhoid group, a commission on systematic relations was created by the last International

Congress on Hygiene and Demography, of which Dr. Weber, of Berlin, is chairman and the president and two past presidents of this society are the American members. I believe this to be a fitting time for a more far-reaching attempt to criticize and collate and systematize the work which has been done in many countries and by many observers on the characterization and classification of bacterial types. The inception of such a plan may very properly come from the Society of American Bacteriologists which through its standard card has already done so much for the development of the purely descriptive side of our science. As a practical outcome of this long survey of the problems of systematic bacteriology, with which you have borne so patiently, I suggest that we invite fifteen bacteriologists from the principal scientific countries to act as an international commission on the characterization and classification of bacterial types, with the general objects outlined above. If you should approve this plan, and if we can secure the cooperation of investigators of the first rank (as I have no doubt will be the case), I believe that we can thus render to bacteriology a great practical service, worthy of the highest aims which our society has held in view.

C.-E. A. WINSLOW

AMERICAN MUSEUM OF NATURAL HISTORY

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#### ACADEMIC STUDENT ELECTIONS

IN SCIENCE, October 24, 1913, are some interesting tables exhibiting the results of much

patient work by Dr. Frederick C. Ferry, dean and professor of mathematics in Williams College. His tables give the registration of students taking various subjects of study in eighteen American colleges and universities. These subjects are commonly divided into three groups, roughly determined by the nature of the topics included. Thus, group I. may be called the "language group"; group II., the "humanities group"; and group III., the "science group." The distribution of work in each of these groups in any given college affords some indication of the popularity of the group. To express this distribution it is necessary to give, as Dean Ferry has done, for each subject the number of "student hours of instruction." In view of the great variation in total attendance at different colleges Dean Ferry has reduced his figures to percentages, on a semester basis, limiting them to undergraduates in the academic college.

On examining Dean Ferry's tables the present writer perceived the possibility of making the comparisons somewhat more pointed, and of securing a fair representation of popularity not only for groups but for separate subjects of study. A "student-hour of instruction" may be interpreted to mean one hour per week in the classroom, taken by one student throughout one semester. The actual work done includes an estimated pair of hours spent in study in preparation for the work of the classroom. This estimate is often not realized, the student taking his chances of escaping a test, especially if the class is rather large. Two or three hours in the laboratory are hence fairly counted as the equivalent of one hour in the classroom. Let  $h$  denote the value in student-hours for a given course; for example, if the student has 3 meetings per week in the classroom and 2 afternoons per week in the laboratory, then  $h = 5$ . Let  $n$  denote the number of students taking this course during a given semester; then  $nh$  denotes the work done in this course.

Now, let  $\Sigma(nh)$  denote the work done in the sum of all the courses of a given subject; for example, there may be four courses in physics. Let  $A$  denote the whole academic work in stu-

dent hours done in all subjects in the college during a semester. Then the quotient of  $\Sigma(nh)$  by  $A$  yields a percentage,  $p$ , that expresses the numerical demand for this special subject by the students, on the assumption that there is freedom of election of studies. Various local considerations apart from the nature of the subject are often operative in determining the student's election; such as the personal popularity of the professor and the reputation of his courses for ease or difficulty. English, for example, may be a "soft snap" under one professor and a formidable stumbling block under another. The evils connected with freedom of election, especially for freshmen and sophomores, are increasingly appreciated by educators; so that the assumption of unlimited freedom is now, happily, not quite warranted.

for a semester. If the value of  $p$  for a selected subject is found in eighteen or twenty different colleges, the average of these values may be expressed by  $P$ . This average will of course be affected with enough uncertainty to be expressed as an integer. Thus, if the numerical popularity of French comes out as 8.74, and of physics as 4.37, the corresponding percentages would be taken as 9 and 4, respectively; indicating that out of the work done in these colleges about 9 per cent. may be expected to be in French, and about 4 per cent. in physics; or that the popularity of French is more than double that of physics, though the exact numerical results, 8.74 and 4.37, would seem to indicate an exact ratio of 2 to 1, which has to be taken with some grains of allowance.

TABLE OF PERCENTAGES

	<i>p</i> (max.)		<i>P</i>	<i>p</i> (min.)	
GROUP I.:					
Greek.....	Yale,	3.91	2	Wisconsin,	0.41
Latin.....	Bryn Mawr,	12.87	5	Harvard,	1.89
Germanic Languages.....	Wisconsin,	12.85	8	Princeton,	4.49
Romance Languages.....	Dartmouth,	13.28	4	Oberlin,	5.75
24.50			29		
GROUP II.:					
English.....	Mt. Holyoke,	21.84	16	Stanford,	10.46
History.....	Yale,	12.88	9	Amherst,	4.79
Political Science.....	Cornell,	12.75	5	Oberlin,	2.02
Economics.....	Harvard,	12.65	7	Amherst,	2.98
Philosophy.....	Columbia,	12.59	6	Stanford,	2.92
Bible.....	Wellesley,	8.01	4	Princeton,	0.06
46.78			47		
GROUP III.:					
Mathematics.....	Princeton,	11.46	8	Bryn Mawr,	2.04
Astronomy.....	Mt. Holyoke,	1.87	1	Wisconsin,	0.11
Physics.....	Johns Hopkins,	7.54	4	Oberlin,	1.20
Chemistry.....	Cornell,	12.95	6	Wellesley,	1.84
Biology.....	Wesleyan,	13.36	5	Bowdoin,	2.55
Geology.....	Wisconsin,	4.24	2	Smith,	0.53
28.72			26		
100.00			97		

But the student who aims at a bachelor's degree finds himself often put to the necessity of choosing between what he regards as evils. By taking an average of such elections in a considerable number of colleges the personal element is to some extent eliminated.

The percentage,  $p$ , is obviously a rate, substantially the same for an annual session as

In the accompanying table these integral percentages are given in the middle column, as the result of studying Dean Ferry's tables. To show the range of variation the maximum and minimum values of  $p$  are additionally tabulated, along with the names of the corresponding institutions. Thus, the popularity of Greek is greatest at Yale and least at Wis-

consin. Nearly 4 per cent. of the academic work at Yale is in Greek, while at Wisconsin it is less than half of one per cent. The general popularity of this subject in the eighteen institutions compared is seen to be 2 per cent. The eighteen institutions selected by Dean Ferry are Amherst, Bowdoin, Bryn Mawr, Columbia, Cornell, Dartmouth, Harvard, Johns Hopkins, Mount Holyoke, Oberlin, Princeton, Smith, Stanford, Wellesley, Wesleyan, Williams, Wisconsin and Yale.

In making out the present table a number of subjects of small popularity have been excluded, such as Sanskrit, Slavic languages, archeology, anthropology, art, music, Semitics, Egyptology, veterinary science, history of science, etc. Their total value is 3 per cent., so that the sum of the recorded work for column *P* is 97 instead of 100; but, for each subject included, the value of *P* was made out on the basis of 100. The total for group I., as recorded in Dean Ferry's table, is seen to be 24.50 instead of 24; for group II., 46.78 instead of 47; for group III., 28.72 instead of 26. It will be noted that everywhere the tendency seems to be for students to crowd their work into group II., the amount of work taken in this group being nearly as great as in both of the other groups put together. Apart from the interesting humanistic character of the subjects included, they are wholly free from the intricacies of grammar and especially of mathematics.

English naturally leads in importance, with 16 per cent.; and mathematics, in spite of its rigors, presents 8 per cent. These high rates are partly accounted for by the fact that in most, if not all, American colleges these two subjects are prescribed, at least for freshmen; so that here the assumption of freedom of election is in large measure to be discarded.

For the 16 subjects represented in the table, with total value 97, the average percentage obtained by dividing 97 by 16 is a little over 6. This number may hence be taken as a rough standard for comparing the student demand for different subjects; or, for the average extent to which a subject may be studied, whether prescribed or elected. This

average of 6 per cent. is not reached by astronomy, Greek, geology, physics, Bible, Latin, political science or biology. It is reached by philosophy and chemistry. It is exceeded by economics, Germanic languages, mathematics, Romance languages, history and English.

The table shows that the study of astronomy, so nearly universal in the senior classes of American colleges two generations ago, has now nearly vanished, being only half as much pursued as that of Greek; and this in turn was a subject of the first importance among our grandfathers. The popularity of astronomy is expressed by 1.87 at Mount Holyoke, a woman's college, where the teaching of this subject seems to be conducted with much pedagogic skill. It is least at Wisconsin, where the percentage number is only 0.11, despite the fact that the professor in charge, a man of international reputation, has done much original work.

Geology, a department of science which, as taught in our colleges, can not be compared with astronomy in mathematical difficulty, seems to maintain in these a degree of popularity about the same as that of Greek, 2 per cent., or one third of that of chemistry and of philosophy.

Physics and Bible study are apparently of equal popularity, about half of that of mathematics, and two thirds of that of chemistry. The demand for Bible study is by far greatest in institutions for women. It is expressed by 8.01 at Wellesley; 6.62 at Mount Holyoke; 5.88 at Oberlin. It is only 0.21 at Yale, where Y. M. C. A. influence is most widely diffused and voluntary attendance on morning chapel exercises throughout the annual session is maintained by popular demand. It is only 0.06 at Princeton, the presbyterian stronghold, which is fortified additionally by the power of the adjacent theological seminary.

The average percentages just discussed should be interpreted only as variables which indicate the modern academic trend. The range of variation for the particular list of colleges compared is worth noting in the first and last columns of the table. In every indi-

vidual college it may be expected that local influences will produce marked deviations from the indications of the table. But, none the less, the figures seem to be of enough educational value to be published.

W. LE CONTE STEVENS

WASHINGTON AND LEE UNIVERSITY,  
December 24, 1913

#### SCIENTIFIC NOTES AND NEWS

PROFESSOR THEODORE RICHARDS, of Harvard University, has been elected president of the American Chemical Society for the year 1914. M. T. Bogert and A. D. Little have been elected directors and C. H. Herty, Julius Stieglitz, L. H. Baekeland and W. L. Dudley councilors-at-large for a three-year period.

PROFESSOR R. S. WOODWORTH, of Columbia University, was elected president of the American Psychological Association at the recent New Haven meeting. Professor R. M. Ogden, of the University of Tennessee, was elected secretary for a three-year period.

At the recent Princeton meetings, Dr. George F. Becker, of the U. S. Geological Survey, was elected president of the Geological Society of America, and Professor A. P. Brigham, of Colgate University, was elected president of the American Society of Geographers.

THE Society of American Bacteriologists, at its Montreal meeting, elected Professor Charles E. Marshall, of Amherst, to the presidency and Professor F. C. Harrison, of MacDonald College, to the vice presidency.

It is proposed to present to the Royal Society a portrait of the retiring president, Sir Archibald Geikie, the distinguished geologist. A committee, with Sir William Ramsay as chairman, has been formed to collect subscriptions, which it is agreed should not exceed three guineas.

PROFESSOR W. B. SCOTT, of Princeton University, and Professor E. L. Trouessart, of Paris, corresponding members of the Zoological Society of London, have been elected foreign members of the society. Professor E. Ehlers, Göttingen, Mr. J. H. Fleming, To-

ronto, and Dr. C. Gordon Hewitt, Ottawa, have been elected corresponding members of the society.

DR. ALBERT ERNEST JENKS, professor of anthropology in the University of Minnesota, has been granted leave of absence from the university the second semester of the current year. Certain aspects of ethnic amalgamation, and environmental influence will be given field study. He will spend February and March in the southern part of the United States, and the next five months in Europe and northern Africa.

At a meeting of the State Geological Commission of Oklahoma late in December, the resignation of D. W. Ohern as director of the Oklahoma Geological Survey was accepted. L. C. Snider, the assistant director, declined to consider the directorship and C. W. Shannon, field geologist, was appointed director. The personnel of the scientific staff of the Survey as now constituted is as follows: C. W. Shannon, A.B., A.M. (Indiana), director; L. C. Snider, A.B., A.M. (Indiana), assistant director; L. E. Trout, A.B., A.M. (Oklahoma), field geologist; Wm. A. Buttram, A.B. (Oklahoma), chemist.

A SERIES of three lectures has been planned for the classes of blind children that visit the American Museum of Natural History. In the first of these on December 18, Admiral Robert E. Peary recounted some of the experiences of his memorable Arctic journey which resulted in the attainment of the North Pole.

THE Herter Lectures of the University and Bellevue Hospital Medical College will be given during the week beginning January 12, 1914, at Carnegie Laboratory, 338 East 26th Street, New York City. Professor Sven Hedin will lecture on "Colloids and their Relation to Biological Chemistry."

At a recent meeting of the Abernethian Society at St. Bartholomew's Hospital, London, Sir William Osler delivered an address on "The Medical Clinic—a Retrospect and a Forecast."

PROFESSOR E. M. EAST, of Harvard University, delivered in December a lecture entitled

"The Improvement of Plants by Hybridization" before a joint meeting of the "Garden Association" and the Horticultural Society of Newport, R. I.

At the Dropsie College for Hebrew and Cognate Learning, Philadelphia, Dr. Ignaz Zollschan, of Vienna, will deliver three lectures on January 14, 15 and 19 on "The Cultural Value of the Jewish Race," "The Significance of the Mixed Marriage" and "Tendencies of Economic Development Among the Jewish People."

The *Journal of the American Medical Association* states that on December 11, the day on which he would have completed his seventieth year, there was instituted a quiet memorial in memory of Robert Koch by Professor Loeffler, the present director of the Institute for Infectious Diseases in Berlin, in the Robert Koch mausoleum. The entire board of directors of the Robert Koch foundation for the campaign against tuberculosis took part in the celebration. Memorial wreaths were placed in the mausoleum by this as well as other corporations, and in honor of the memorial day the *Deutsche medizinische Wochenschrift*, the regular organ of publication of the great bacteriologist, issued a special number to which interesting contributions were furnished by the most noted pupils of Robert Koch, Loeffler, Ehrich, Brieger, H. Kossel, Uhlenhuth, Pfeiffer, Kolle and others.

SIR JOHN BATTY TUKE, Unionist member for Edinburgh and St. Andrews Universities 1900-1910, the authority on mental diseases, left to the Royal College of Physicians, Edinburgh his bust by John Hutchison.

It is proposed to place a tablet suitably inscribed to commemorate Benjamin Franklin in the Church of St. Bartholomew the Great, West Smithfield—the parish in which he worked as a printer. Subscriptions for this memorial may be sent to Mr. E. A. Webb, 60 Bartholomew Close, London, E.C.

PROFESSOR WINSLOW UPTON, head of the astronomical department of Brown University, and director of the Ladd Observatory, died on January 8, aged sixty-one years.

THE twelfth general meeting of the Association of Economic Biologists was held at Liverpool on December 30 and 31.

DR. TEMPEST ANDERSON, known for his studies of volcanoes, has left £50,000 to the Yorkshire Philosophical Society, of which he was formerly president, and £20,000 to the Percy Sladen Memorial Fund, established by his sister, Mrs. Sladen, in 1904.

THE family of the late Dr. Javal, the distinguished ophthalmologist, has given to the Eye Clinic of the Paris Hôtel-Dieu the fine library which he had collected in his ophthalmological laboratory at the École des Hautes Études in the Sorbonne. Madame Javal has completed the large collection of French and foreign periodicals up to the end of 1913.

SIR ARTHUR EVANS has, as we learn from *Nature*, presented to the museum at Cambridge the last instalment of an interesting set of objects selected from the collections of his father, the late Sir John Evans. The gift consists of 121 specimens ranging in date from prehistoric times to the eighteenth century. The value of the collection is greatly enhanced by the fact that all the specimens composing it were found in Cambridgeshire and the adjacent counties.

IN the alcove of the North American archeology hall of the American Museum of Natural History a mural series has recently been completed. It consists of five polychrome frescoes, three of which are enlarged copies of the frescoes on the walls of the cavern of Font-de-Gaume in France and two are enlarged copies from the ceiling of Altamir in Spain. The originals of these represent paleolithic art at its highest point of perfection. The copies were made by Mr. Albert Operti.

DR. CARLOS DE LA TORRE of the University of Havana, Cuba, has made a very interesting and valuable addition to the collection of conchology in the department of invertebrate zoology. This material was secured by Dr. F. E. Lutz in his recent visit to Cuba and consists of land shells, many of which are described by Dr. La Torre.

THE faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, on Sunday afternoons, beginning January 4, and ending May 10, 1914. The lectures, which begin at four o'clock, are as follows:

January 4. "Recent Studies of the Bodily Effects of Fear and Rage," by Dr. W. B. Cannon.

January 11. "Rational Infant Feeding," by Dr. John Lovett Morse.

January 18. "The Effects of Habits of Posture upon Health," by Dr. J. E. Goldthwait.

January 25. "The Tumors and Diseases of the Breast." (To women only.) By Dr. R. B. Greenough.

February 1. "Some Surgical Diseases of Childhood and their Causes," by Dr. J. S. Stone.

February 8. "Adenoids and Tonsils," by Dr. A. Coolidge, Jr.

February 15. "Microscopical Mechanisms of the Brain," by Dr. Charles S. Minot.

February 22. "Some Causes of Nervous Instability," by Dr. E. W. Taylor.

March 1. "Tooth Preservation in Children and Adults," by Dr. William P. Cooke.

March 8. "Skin Nostrums," by Dr. Charles J. White.

March 15. "Chairs, Backache and Curved Spine," by Dr. E. H. Bradford.

March 22. "Spectacles and Eye-glasses; their Use and Abuse," by Dr. Charles H. Williams.

March 29. "Diet in Relation to Diseases of the Kidney," by Dr. E. P. Joslin.

April 5. "Aid for the Deaf," by Dr. Clarence J. Blake.

April 12. "Eugenics versus Cacogenics," by Dr. E. E. Southard.

April 19. "The Hygiene of Pregnancy." (To women only.) By Dr. F. S. Newell.

April 26. "The Diagnosis and Immediate Treatment of Lesser Injuries, including the Use and Abuse of Antiseptics," by Dr. J. Bapst Blake.

May 3. "Arterio Sclerosis," by Dr. W. H. Smith.

May 10. "The Sexual Instinct; its Use and Abuse." (To men only.) By Dr. E. H. Nichols.

THE following are the principal prizes, as we learn from the *British Medical Journal*, awarded by the Paris Academy of Medicine this year. The Louis Boggio prize (triennial, of the value of £172) has been given to M. H. Vallée, director of the Veterinary School of

Alfort, for his researches on the prevention and cure of tuberculosis. The Adrien Buisson prize (triennial, of the value of £420), for the discovery of means of cure of diseases considered incurable, has been awarded to Dr. Dopter, professor in the École d'Application of the military health service, for his work on epidemic cerebro-spinal meningitis, the meningococcus, antimeningococcic serum, parameningococci, and antiparameningococcic serum. The Chevillon prize (£60), for the best work on the treatment of cancer, has been awarded to Dr. R. Robinson, of Paris, for his account of a method of biochemical diagnosis of cancerous affections. The Herpin (of Geneva) prize, for the best work on epilepsy and nervous diseases, has been awarded to Dr. André Barbé, of Paris, for his study of secondary (bulbo-protuberantial and medullary) disease of the pyramidal bundle. The Laborie prize (£200), for the greatest progress in surgery, has been given to Dr. Guisez, of Paris, for his work on branchio-esophagocopy. The Meynot prize (£104), for the best work on diseases of the eye, has been awarded to Dr. F. Bourdier, of Paris, for his essay on the optic meninges and primary optic meningitis. The Roger prize (quinquennial, of the value of £100), for the best work on diseases of children, has been given to Professor E. Weill, of Lyons, for his book, "Précis de médecine infantile." The Tarnier prize (£120), for the best work on gynecology, has been awarded to Drs. P. Puech, of Montpellier, and J. Vanverts, of Lille, for their book, "Tumors of the Ovary and Pregnancy." The Tremblay prize (quinquennial, of the value of £284), for the best work on urinary diseases, has been awarded to Dr. E. Papin, of Paris, for an essay on the sexual functions and prostatectomy. Among the principal prizes of the Académie des Sciences are the Montyon prize in medicine and surgery; three, each of the value of £100, have been awarded to Madame Lina Negri Luzani, of Paris, for studies on the corpuscles, which, in conjunction with her late husband, she discovered in the nervous system of mad dogs; to Dr. L. Ambard, of Paris, for his

memoir on the renal secretion; and to M. A. Railliet, G. Moussu, and M. A. Henry, for their researches on the etiology, prophylaxis, and treatment of the distomiasis of ruminants. The Bréant prize has been divided as follows: Three prizes, of the value of £80 each, have been awarded to Dr. C. Levaditi, of Paris, for his researches on acute epidemic poliomyelitis and acute infectious pemphigus; to Drs. A. Netter and R. Debré, of Paris, for an essay on cerebro-spinal meningitis; and to Professor V. Babès, of Bucharest, for his treatise on rabies.

THE production of pig iron in 1912 was 33,802,685 tons of 2,000 pounds each; that of platinum was 1.3 tons. The value of the iron per ton was \$12.44, as against \$1,328,391 per ton for the platinum. For the sake of convenient comparison and because in commercial practise the various ores and metals are measured by a variety of units such as the long, short and metric ton, flask, avoirdupois pound and troy ounce, the United States Geological Survey has issued a short summary of the "Production of Metals and Metallic Ores in 1911 and 1912," stated in terms of the short ton of 2,000 pounds, much of which, however, is derived from imported ores, bullion, etc. A comparison of the production of some of the better known metals is as follows:

	Quantity	Value
Platinum.....	1.304	\$ 1,732,221
Gold.....	188.108	113,415,510
Silver.....	4,471.4	80,187,317
Aluminum.....	32,803	15,089,380
Quicksilver.....	939.9	1,057,180
Nickel.....	22,421	17,936,800
Tin.....	8.4	8,850
Copper.....	734,052	242,337,160

THOUGH at one time in the early history of the country an average of 6,000 maple trees were destroyed in clearing the ordinary New York or Pennsylvania farm, maple is to-day, according to the department of agriculture, one of the most widely used and valuable native hardwoods. A bulletin on the uses of maple, just issued by the department, states that the wood finds place in an enormous number of articles in daily use, from rolling pins to pianos and organs. It is one of the best

woods for flooring, and is always a favorite material for the floors of roller skating rinks and bowling alleys. It leads all other woods as a material for shoe lasts, the demand for which in Massachusetts alone exceeds 13 million board feet annually. Sugar maple stands near the top of the list of furniture woods in this country. The so-called "bird's-eye" effect, the department explains, is probably due to buds which for some reason can not force their way through the bark, but which remain just beneath it year after year. The young wood is disturbed each succeeding season by the presence of the bud and grows around it in fantastic forms which are exposed when the saw cuts through the abnormal growth. Maple, the department goes on to say, is one of the chief woods used for agricultural implements and farm machinery, being so employed because of its strength and hardness. All kinds of wooden ware are made of maple, which holds important rank also in the manufacture of shuttles, spools and bobbins. It competes with black gum for first place in the manufacture of rollers of many kinds, from those employed in house moving to the less massive ones used on lawn-mowers. Athletic goods, school supplies, brush backs, pulleys, type cases and crutches are a few of the other articles for which maple is in demand. Seven species of maple grow in the United States, of which sugar maple, sometimes called hard maple, is the most important. The total cut of maple in the United States annually amounts to about 1,150,000,000 feet. Nearly one half is produced by Michigan, with Wisconsin, Pennsylvania, New York and West Virginia following in the order named. Sugar maple, says the department, is in little danger of disappearing from the American forests, for it is a strong, vigorous, aggressive tree, and though not a fast grower, is able to hold its own. In Michigan it is not unusual for maple to take possession of land from which pine or hardwoods have been cut clean, and from New England westward through the Lake States and southward to the Ohio and Potomac rivers few other species are oftener seen in woodlots.

ON the eastern edge of the campus of the Ohio State University rises a new building of white stone, the new museum of the Ohio State Archeological and Historical Society, which is to house the Indian relics and treasures of the mound builders which make Ohio the richest field of pre-historic remains in the United States. With the first week of the New Year the collections will be moved from their old home in Page Hall to their beautiful new building. The structure itself is as nearly fireproof as man can make it, utilizing stone, steel and concrete, with no wood used in its construction. Almost all the furniture is made of steel and the entire library and offices are similarly built. The exhibition rooms are entirely of mahogany as steel cases are impracticable. It is planned to have a formal opening in January, with appropriate exercises and public inspection of the rare collections housed in the building, appropriations for which were authorized at a recent session of the Legislature. Professor G. Frederick Wright, of Oberlin, is president of the society and Professor W. C. Mills, of Columbus, its curator.

At the recent meeting of the American Ornithologists' Union in New York City, as we learn from *The Auk*, the advisability of changing the time of meetings from fall to spring was considered. This innovation was favored for two principal reasons: First, to make it possible for those members to attend who, for business or other reasons, were unable to leave home in the autumn. Second, members residing on the Pacific Coast are very anxious that the stated meeting in 1915 be held in San Francisco while the World's Panama-Pacific Exposition is in progress. It was the consensus of opinion that spring was the most favorable time to hold this meeting and to successfully carry out the plan, it was thought advisable to allow at least a year to intervene between the Washington and San Francisco meetings. This would give members throughout the country ample time to plan in advance for the journey across the continent. In this connection it is to be remembered that the expense of the transconti-

mental trip will be greatly reduced if a considerable number of members and their friends attend. With the above plan in mind, the Committee of Arrangements has decided to name Easter week, beginning with April 6, 1914, as the best time for the Washington meeting.

#### UNIVERSITY AND EDUCATIONAL NEWS

THE late Right Hon. G. W. Palmer bequeathed £10,000 to University College, Reading, and it is now announced that Mr. Alfred Palmer has suggested that this legacy should be devoted to building a university library, and on behalf of Mrs. G. W. Palmer, his sisters, and himself, has offered to supplement it to such extent as will be necessary to enable a suitable library to be built on the site reserved for the purpose, and also to provide an endowment fund for maintenance.

GOLD HALL, a dormitory of the group of original buildings at the Connecticut Agricultural College, was burned to the ground on January 4, with a loss of \$10,000.

THE Stevens Institute of Technology announces that, beginning with the year 1914, admission to its freshman class will be either by certificate or examination. Students will be admitted to the freshman class on certificates from secondary schools which have been placed upon the accepted list by the faculty.

THE civil engineering department of the engineering college of the University of Illinois offers a two weeks' course, January 19-31, to aid the newly appointed county superintendents of highways in preparing for their duties. In this the university will be aided by the state highway commission, whose engineer will be one of the leading speakers. The work is in charge of Professor Ira O. Baker, head of the department of civil engineering. The ceramics department offers a course, January 12-24. It is open to all who are engaged in factory operations. The process of clay testing, preparation, molding, drying, burning and decorating are to be treated. The work will be under the direction of R. T. Stull, acting director of the department, and Professor A. V. Bleining, ceramic chemist, Bu-

reau of Standards, Pittsburgh, Pa. The agricultural department offers this year, January 19-31, some new courses in forge work and carpentry. These courses will under the immediate charge of Director Benedict, of the mechanical engineering department.

At the Massachusetts Institute of Technology Dr. H. O. Taylor has been appointed to be research associate in the research laboratory of electrical engineering, and Francis Byron Morton to be assistant in physics, in place of F. I. Hunt, resigned.

At Vassar College Dr. Elizabeth B. Cowley, instructor in mathematics, has been made assistant professor of mathematics.

THE governors of the Imperial College of Science and Technology have constituted two new chairs of chemistry, and appointed two new professors—Dr. Jocelyn Field Thorpe, professor of organic chemistry, and Dr. James C. Philip, professor of physical chemistry.

#### DISCUSSION AND CORRESPONDENCE

##### ON THE IDENTITY OF VERRUGA AND CARRION'S FEVER

WE are indebted to Dr. Richard P. Strong, of the Harvard Medical School, for reopening the question of the unity or duality of Carrion's fever and eruptive verruga, so termed. Assisted by Dr. E. E. Tyzzer, he carried out an interesting series of experiments at the bacteriological laboratory of the Institute of Hygiene in Lima, from June to August, 1913, in cooperation with Dr. Júlio C. Gastiaturú, the director of that laboratory. Some of the details of the results obtained were presented to the Fifth Latin American Medical Congress in Lima by Dr. Gastiaturú on November 14, 1913, causing a great sensation in Peruvian medical circles. It is not too much to say that this announcement has fallen like a thunderbolt in Lima. The thorough probing of the problem which will undoubtedly follow swiftly upon this reopening of the case will certainly bring the truth to the surface and settle the matter with finality. From the entomological and protozoological points of view, as well as from such clinical and other

points of view as present themselves to the writer, the following data seem to bear definitely upon this subject.

##### *Reasons why Carrion's fever and eruptive verruga (so-called) are respectively malignant and benign forms of one disease:*

1. They have identically the same geographical distribution so far as known.
2. They are connected by every possible gradation of clinical symptoms.
3. The bone pains which are characteristic of the benign form often occur with marked severity associated with such high temperatures that the case must be diagnosed as malignant or Carrion's fever rather than benign or eruptive verruga (so-called).
4. Carrion's fever is always followed by the eruption, usually of the miliar but sometimes of the nodular type, the latter being more distinctive of the benign form of the disease, this indicating the identity of the malignant and benign forms etiologically.
5. Infection by *Phlebotomus verrucarum* from the same locality produces both in both man and laboratory animals, sometimes giving rise to one and sometimes to the other, apparently according to the severity of the infection due to the number of the infective *Phlebotomus* concerned or to the degree of resistance of the host infected.
6. The bodies named *Bartonella bacilliforme* by Strong and Gastiaturú are present in both, their abundance being apparently in direct ratio to the degree of fever exhibited at any time in any given case of either, and they disappear from the peripheral circulation of both immediately before the appearance of the eruption, though they may return if the course of the eruption be interrupted by pyrexial relapse, disappearing finally on the definite and uninterrupted sequence of the eruption.
7. The bodies *Bartonella bacilliforme* are quite evidently not organisms, but changes wrought in the red cells by the activities of the as yet undiscovered verruga organism, these changes evidently being effected in the bone marrow, as evidenced by the fact that the more abundant the *Bartonella* bodies are the

more abundant are normoblasts, megaloblasts and other abnormal red cells in the peripheral circulation.

8. Neither Carrion's fever nor verruga eruption can be produced in either man or laboratory animals by the injection of blood containing the *Barton* bodies alone, but both can be produced in man by injection of the virus from the human eruption, and the benign form can be produced in laboratory animals by such injection, the reason why the acute form has not been similarly produced being that either the animals are far less susceptible to the disease than man or the toxicity of the virus becomes attenuated for them after running its course in man, though experience indicates that it may yet be so produced in monkeys if not in other animals.

9. The pathologic microorganisms transmitted by *Phlebotomus* in all parts of the world so far as known invariably set up an initial fever stage of longer or shorter duration and greater or less intensity, and verruga eruption is in every case preceded by some degree of pyrexia, though sometimes so slight as to be hardly noticeable.

10. The eruption following Carrion's fever as well as the eruption preceded by mild fever or an almost unappreciable degree of fever both show a marked tendency to appear first at the sites of inoculation by the *Phlebotomus* and to become most pronounced at such sites.

11. Cases of eruption following either often if not always confer immunity against both.

12. *Phlebotomus verrucarum* gets its infection certainly from some reservoir, probably one of the native mammals, but whether from the lower mammals or man it is practically certain that the reservoir of infection supplies but one kind of microbe capable of developing in and being transmitted by the carrier.

13. Both are amenable to the same treatment so far as this has been determined for either.

All of the above facts have been verified by the writer's work and experience during his investigation of verruga transmission in the verruga zones and in the laboratory. Severe pyrexia has resulted in a *Cebus capuchinus*

from the bites of the *Phlebotomus*, the rectal temperature passing 43° C. and the red cells showing the *Barton* bodies. Miliar eruption succeeded. The *Barton* bodies have also been found by the writer in the red cells of dog, rabbit and guinea-pig inoculated with the *Phlebotomus*. Eruption away from site of inoculation has been produced in a hairless dog by hypodermic injection of over 400 *Phlebotomus* in five lots, mashed up in physiological solution. Upon the excision of a large nodule, another has grown in its place. The writer's assistant in the verruga work, Mr. George E. Nicholson, is in the hospital with verruga, the result of 55 bites by *Phlebotomus* September 17 last at Verrugas Canyon, due to inadvertently getting his hands in contact with the net while asleep. His symptoms have been high fever with severe bone pains, and a large number of *Barton* bodies in the red cells. Details of the experiments with laboratory animals will shortly be presented, including blood and tissue studies, temperatures and weights, with illustrations.

Almost any one of the above reasons, taken by itself, would seem to indicate conclusively the unity of verruga. If Dr. Strong's thesis can be made to harmonize with all of these facts, then it is possible that he is right, but the indications seem to point strongly the other way. CHARLES H. T. TOWNSEND

VERRUGA LABORATORY,  
CHOSICA, PERU,  
November 17, 1913

#### SCIENTIFIC BOOKS

*Scott's Last Expedition*. Vol. I., being the Journals of CAPTAIN R. F. SCOTT, R.N., C.V.O. Vol. II., being the Reports of the Journeys and the Scientific Work undertaken by DR. E. A. WILSON and the surviving members of the Expedition. Arranged by LEONARD HUXLEY, with a preface by SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S. With 18 colored plates, 260 full-page and smaller illustrations. New York. Dodd, Mead and Company, 1913. Large 8vo. 2 vols. xxiv + 443, xiv + 376 pp. 8 maps. \$10.00 net.



It is many years, if ever, since the civilized world has been so stirred into homage to courage and to sympathy for disaster, as were displayed when the ocean cables spread over the globe the fateful story of Scott's Last Expedition, which is now told in these beautiful volumes. Suffice it to say that the detailed record shows high planes of project and of action, which should ensure to Commander Evans and his surviving associates scarcely less honor and credit than is given so fittingly to Scott and his heroic dead.

That recognized polar authority, Sir Clements R. Markham, outlines the aims and scope of Scott's expedition as the "completion and extension of his former discoveries," especially of "fossils, which would throw light on the former history of the great mountains," which bound the south-polar plateau. For this work Scott had "the most completely equipped expedition for scientific purposes connected with the polar regions, both as regards men and material," and "a fuller complement of geologists, biologists, physicists and surveyors than ever before composed the staff of a polar expedition." Science was the primary aim, so that Scott had removed the taint of commercialism, which caused Milton to qualify his praise of the quest of a northern route to China by saying it "might have seemed almost heroic if any higher end than excessive love of gain and traffic had animated the design." Thus a twentieth-century sailor attained the seventeenth century ideal of heroism.

Referring briefly to the south-polar journey, it is clear that Scott's plans were perfected and carried out with striking ability. Despite a season of unprecedented severity as to blizzards and cold, the party would have survived but for other misfortunes. These were the inability to originally occupy Cape Crozier as a base, owing to ice-conditions; the breakdown and loss of motor sledges; and especially the deep, soft snow that fell during the four-day blizzard at Beardmore glacier on the outward journey. Later came the death of Evans from crevasse-injuries and sastrugi-falls, and the freezing of heroic Oates, which followed close on the time lost and delays caused by geologi-

cal work, a primary aim be it remembered. Let the readers of SCIENCE bear in mind that these men perished indirectly as martyrs to a sense of scientific duty. The day spent in collecting the fossil volumes that may tell the story of past geological history, and the strength consumed in dragging these specimens, nearly forty pounds in weight, exhausted the fatal limit of time and so sealed their fate. Yet no word is uttered suggestive of abandoning their harrowing load, over frightful mazes of sastrugi and of glacier.

This is not the place to dwell on the ideals of courage, of devotion, of unselfishness, which ran like the King's red thread through the warp and woof of their expeditionary duties—of the living as well of the dead. Their recital moves the hearts of the present, and will serve as exemplars to stir the souls of the future.

Storm-bound and crevasse-injured, the southern party perished to a man within eleven miles of safety, while ending a sledge journey of more than sixteen hundred miles,—unprecedented for its length in polar annals. As to conditions which prevented that short march to food and fuel, they had for the ten previous days traveled in temperatures averaging sixty-eight degrees below freezing (this in March, *our September*), and were enveloped in a blinding blizzard, which lasted continuously for eight days.

In these transcripts from Scott's diary are no words of adverse criticism when he received the astounding news that a rival was in the field,—for south-polar travel only be it noted. Amundsen's route being shorter, foreseeing the probability of being forestalled at the pole, Scott recalls with becoming dignity of soul the scientific scope of his work in the sober statement, on September 10, 1911, that "nothing, not even the priority at the Pole, can prevent the expedition ranking as one of the most important that ever entered the polar regions."

Severe as were the physical experiences of the south-polar party in their dramatic explorations, they entailed relatively less bodily discomfort and acute suffering than did the midwinter journey for strictly scientific pur-

poses to the penguin rookery at Cape Crozier. The object of the trip was to secure eggs of the emperor penguin—a species most nearly approaching the primitive form of bird—at such stages of early embryos as might make clear the development of the emperors. A journey in midwinter was necessary as the singular emperor penguin is perhaps unique in nesting at the coldest season of the year—in temperatures approximating one hundred degrees below the freezing point of water.

Apart from the weather the trip involved sledge travel of two hundred miles in almost complete darkness, wherein the party must cross the crevassed "barrier" and finally pass through the chaotic pressure-ridges of the shore-impinging sea floes. The journey was made without disaster, and three eggs brought safely home, but this scientific work tested humanity to the utmost. The outward march was made in eighteen days with an average temperature of minus forty degrees—that of frozen mercury. Only once did the temperature rise to zero Fahr., and a minimum of one hundred and nine degrees below freezing was experienced. A violent blizzard, in which an hourly wind velocity of 84 miles was recorded at the home station, blew away their tent and unroofed their hut. Exposed to the fury of the storm they were forty-eight hours without food, uncertain of their fate. They finally recovered their tent, without which they must have perished, for the blizzard temperature of  $+24^{\circ}$  fell steadily to  $-66^{\circ}$  Fahr. For science and not for fame was made a trip unsurpassed as to the severity of cold and violence of storm successfully endured by a field party.

The scientific appendices to these volumes are brief and tentative, as would naturally be expected. Full of thrilling interest and of importance are the accounts of the journeys made for the physiographic and geological explorations of the coast regions of northeastern South Victoria Land. The enforced wintering of Campbell's party, equipped for summer travel only, was on the verge of disaster several times. Wintering in a hut carved out of a snow-covered glacier, they lived for nine months from hand to mouth on penguins and

seals. Other scientists had experiences but little less dangerous and trying. Indeed it may be said that no previous polar expedition has ever surpassed that of Scott in the devotion of its staff to scientific investigations entailing personal, prolonged and perilous service.

Brief chapters treat of scientific work, such as that wonderful survival of the condition of the Ice Age—the so-called barrier of Ross; the physiography and glacial geology of South Victoria, supplemented by a geological history of that ice-clad region; fossils connected with coal-beds, and those thought to be suited to settle the controversy as to the nature of the connection of Australia and Antarctica; and as to ice physics. Meteorology, tides, magnetism, pendulum work, and atmospheric electricity are treated, though incompletely, while the local sea-work is supplemented by a summary of the biological investigations carried on by the *Terra Nova* in her voyages from 1910 to 1913. Volcanic investigations were pursued on Mt. Erebus, and fossil evidences were obtained from the Great Beacon Sandstone Series.

No previous volumes of polar narrative have been so fully and appropriately illustrated as this thrilling story of the work of Scott's Last Expedition, largely due to Dr. Wilson and Mr. Pointing. Not only do the illustrations please the artistic sense, but many will also be of permanent value to scientific students. This is especially true of the photographic plates showing glacial conditions, and the many beautiful reproductions of snow and ice forms. Nor can one neglect those of birds and seals, of mountains and clouds, and even of blizzards. Among the 278 full-page plates will be found some which will convey ampler and clearer ideas to experts than does the written word.

The editorial supervision must have been hasty, for there are many slips and the text is overburdened—detracting from the dignity of the narrative. The main map is most unsatisfactory. Oates Land does not appear thereon. It is an offence to Americans that not only is Wilkes Land omitted from the key map, but it

has been replaced by King George V. Land; patriotic but a sad blunder.

The appreciation accorded to the Scott expedition excites reflections as to the contrasting attitude of the United States and of European governments towards scientific work that is neither commercialized nor exploited. Strikingly similar in aims, in accomplishment and in fateful disaster were the Lady Franklin Bay International Polar Expedition and Scott's Last Expedition. The former—a governmental enterprise—penuriously fitted, its scientific work largely entrusted to enlisted men—who were actuated largely by love of science—occupied the post of honor and of danger of the eleven cooperating nations. It contributed to a hitherto unequalled degree to arctic hydrography, meteorology, pendulum work and magnetism. Yet its complete success in its scientific purposes, as well as in field-work absolutely free from disaster, was formally requited neither by the government nor by any scientific societies of the United States. It took years of effort on the part of its chief to even obtain the meager lawful allowances and the pitiful pensions.

The English expedition, lavishly equipped, had 7 officers and 12 scientists, whose efforts also increase to a very large degree our scientific knowledge of Antarctica. Its heroic personnel win titles of nobility, promotions and the highest scientific honors, while the public contributed hundreds of thousands of dollars to meet adequately and generously all expeditionary requirements—both material and memorial.

The failure of our government to properly recognize scientific work appears to be due to an antiquated and inherited national policy, which must be to the ultimate detriment of the common weal. This year the attention of the government has been urgently called to untoward conditions, arising from illiberal treatment of expert officials. Distinguished chiefs of several important national bureaus officially report increasing difficulty in maintaining an efficient scientific staff. Unusual and steadily augmenting numbers of scientists and experts are accepting commercial posi-

tions in order to meet the enhanced cost of living.

While American admiration for the Scott expedition was so great that we materially aided in the raising of the memorial fund, our energies should also be employed in urging the adequate recognition of those scientific and professional officials, on whose skill, judgment, and patriotism the future of the democratic government in the western hemisphere must so largely rest.

A. W. GREELY

*Probleme der physiologischen und pathologischen Chemie.* Fünfzig Vorlesungen über neuere Ergebnisse und Richtungslinien der Forschung für Studierende, Ärzte, Biologen und Chemiker. By DR. OTTO VON FÜRTH. II. Band: Stoffwechsellehre. Leipzig, Verlag von F. C. W. Vogel, 1913. Pp. xiv + 717.

The only occasion for adding anything to the favorable impression of Professor von Fürth's lectures which the reviewer has already expressed<sup>1</sup> in reference to the first volume lies in the fact that the newer collection deals with a more specific group of topics: metabolism. The author's underlying plan consists in starting with the nutrients at the very beginning of the alimentary processes and in following the foodstuffs, as far as present knowledge permits, on their travels through the organism to the places where the final derivatives disappear in the unexplored depths of intermediary metabolism. To this is added a discussion of the nature of those ultimate stages of this physiological function which are characterized by the combustion of the food fragments in the living organism. In pursuance of the foregoing scheme the chemistry and physiology of digestion and absorption are reviewed in the light of those newer contributions which take cognizance of the special conditions that pertain in the alimentary canal, with its unique innervation and secretory interrelations.

The attitude of the critic to a contribution like the present one—a book giving evidence on every page of the remarkable familiarity of

<sup>1</sup> See SCIENCE, 1912,

the author with the enormous modern literature of chemical physiology and his sympathy with a treatment of its problems less narrow than is current in many quarters—can not be determined by the same criteria that apply to text-books or laboratory manuals. Von Fürth's lectures make no pretense to systematic formulation of routine topics; they offer something far more stimulating to the advanced student, namely, viewpoints to guide him, and goals to be reached. The limitations of our present knowledge are frankly pointed out. What could be more satisfying than this (freely translated) incidental confession of the author in presenting the subject of purine physiology:

"The sum total of the available observations is so vast that no honorable person, even if he devoted years of effort to this topic alone, could maintain that he had delved into the ultimate depths of the subject and fully mastered it. Yet how perverted it would be if I, who have not devoted myself permanently to this field, were simply to traverse it hastily, contenting myself with a few dogmatic statements. Bear in mind that I am merely attempting, in so far as my efforts permit me to appreciate it, to present to you a picture of this world of phenomena; and do not forget that this picture would appear different to other eyes. It is a human privilege to see the things of the external world with our own eyes; but we must not deceive ourselves into forgetting that it is, after all, a subjective point of view that we take."

Here, as in the first volume, there are personal touches and subjective impressions that lend a sort of enlivening color to the treatment of topics that the usual writer is apt to present in a stereotyped fashion. A few quotations may serve to illustrate what is here meant. The reviewer can not conceal his satisfaction in reading the following:

"Man hat sich vielfach bemüht, die moderne Entfaltung der physikalischen Chemie auch dem Probleme der Salzsäurebildung im Magensaft dienstbar zu machen. Als seinerzeit die Ionenlehre langsam in die biologischen Disziplinen einzusickern begann, konnte man

vielfach die Beobachtung machen, dass eine Übersetzung einer Fragestellung in die Sprache der Ionenlehre mit einer Erklärung verwechselt wurde. Heute ist man sich wohl ziemlich im Klaren darüber, dass, wenn ein Problem in noch so gelehrter Weise mit dem grösseren Publikum schwer verständlichen Fachausdrücken umschrieben wird, man seiner Erklärung nicht näher kommt, als wenn man dasselbe etwa in spanischer oder russischer Sprache formuliert. Leider ist hie und da ein Restchen der Bemühungen mittelalterlicher Magister, durch möglichste Schwerverständlichkeit ihrer hochgelehrten Darstellungen ihrem Auditorium nur so recht zu imponieren, auch noch in der modernen Wissenschaft (insbesondere in der medizinischen) zu verspüren" (p. 10).

The author's attitude toward many open questions is expressed in the concluding sentence of a discussion of the purpose of the complete digestion of proteins to amino acids.

"Dass aber ein Individuum, trotzdem es die allerverschiedensten Proteinsubstanzen mit seiner Nahrung aufnimmt, stets und unter allen Umständen und sein ganzes Leben lang die Spezifität seiner körpereigenen Eiweisskörper in allerstrengster Weise zu wahren vermag, kann ich nur so verstehen und begreifen, dass ich mir vorstelle, jeder Eiweisskörper der Nahrung werde vor der Assimilation sehr wahrscheinlich bis zu den Aminosäuren desintegriert. Doch ist das eine durchaus subjektive Meinung, die ich Sie nur als solche hinzunehmen bitte. Schliesslich kann ja jeder Mensch nur mit seinem eigenen Kopfe denken" (p. 73).

Similarly at the end of an excellent review of the theories of gout, in which he champions Wiechowski's views, von Fürth remarks:

"Es ist mir wohl bekannt, dass andere diese Dinge anders beurteilen;—aber, wie ich schon früher einmal sagte: jeder Mensch kann nur mit seinen eigenen Augen sehen und mit seinem eigenen Kopfe denken. Glücklicherweise kommt jedes naturwissenschaftliche Problem früher oder später in ein Stadium, wo allen subjektiven Auffassungen ein natürliches Ende gesetzt ist und der objektive Sachverhalt

als etwas Selbstverständliches erscheint" (p. 171).

The welcome touches of humor creep in here and there, as in the following conclusion:

"Dagegen ist die Frage der Herkunft endo- und exogener Harnpurine, nachdem allerdings ganze Ströme von Tinte für sie geflossen sind, immerhin so weit gediehen, dass sie (—und das ist immer ein gutes Zeichen—) eigentlich mit wenigen Worten erledigt werden kann" (p. 150).

Again:

"Es macht nun den Eindruck, dass dieses (bisher wenig beachtete) Moment einer beim Gichtiker gesteigerten Affinität der Gewebe der Harnsäure gegenüber dem Kerne des Gichtproblems näher steht, als z. B. die Frage der Harnsäurebindung im Blute, welche so viel Staub aufgewirbelt hat, und mit der wir uns jetzt auch notgedrungen ein wenig beschäftigen müssen" (p. 175).

And in advising a liberal intake of water in gout the author recognizes that he is merely repeating the dicta of empirical practise. Hence he reflects:

"Es wäre hier, wie überall, durchaus unangebracht und verkehrt, wenn wir das, was nüchterne und objektive Beobachter mit ehrlichem Bemühen bei jahrzehntelanger Beobachtung für zweckmässig befunden haben, einfach ignorieren wollten, weil wir dafür keine theoretische Erklärung zu finden wissen. Vergessen wir nie, dass die Beobachtungen richtig und die Theorien falsch sein können und dass ein richtiger Naturforscher die ersteren im allgemeinen höher bewertet als die letzteren. Nur ist das objektive Beobachten insbesondere bei der Therapie chronischer innerer Erkrankungen leider eine unendlich schwierige Sache, daher dieselbe zu allen Zeiten und bei allen Völkern das gelobte Land der wissentlichen und unwissentlichen Charlatanerie war und sein wird" (p. 190).

The admonition to caution, on the other hand, in rejecting the suggestions of science is brought out in a discussion of Friedenthal's proposal to render the common vegetables more readily available in the nutrition of man. Von Fürth writes:

"Der Wunsch, Menschen zu Gras- und Blätterfressern zu machen, mag Ihnen vielleicht auf den ersten Blick recht lächerlich erscheinen. Vergessen Sie aber nicht, dass es nicht immer die schlechtesten Errungenschaften des Menschengeschlechtes waren, (—ich erinnere Sie an die Dampfmaschine, das Leuchtgas und die Elektrizität—), welche in ihren ersten Anfängen von der Mehrzahl der Zeitgenossen nur von der humoristischen Seite aufgefasst worden sind. Vielleicht stehen wir hier vor einer jener Möglichkeiten, das Dasein späterer Generationen leichter zu gestalten, als es den jetzt Lebenden zuteil geworden ist" (pp. 480–481).

It is of little value to refer here to the details of a book so replete with up-to-date information and so readable at the same time. A typical specimen of the care and comprehensiveness with which the facts have been collected and reviewed is furnished by the discussion of the rôle of muscle in glycolysis. The entire story is told from the early work of Cohnheim, through the critique of Embden and his coworkers, to the latest constructive criticism of Levene and Meyer. An example of the intelligent reconciliation of conflicting views is exhibited in the discussion of the origin of endogenous urinary purines:

"Wir werden uns daher bemühen, uns von jeder einseitigen Auffassung fernzuhalten und weder die Leukozyten, noch die Muskeln, noch die Tätigkeit der Verdauungsdrüsen oder Nieren für die endogene Harnsäurebildung ausschliesslich verantwortlich machen, dieselbe vielmehr als den Ausdruck einer jederzeit und in allen Geweben sich vollziehenden Zellabnutzung betrachten" (p. 151).

Von Fürth is at his best in the discussion of the special features of alimentation and the intermediary metabolic phenomena. His treatment of the problems and methods of general metabolism—the balance of matter and energy—is far less detailed, yet always timely. The unbiased attitude is nowhere better shown than in the comments on the status of the much debated questions of the protein minimum in human nutrition and the theories of protein metabolism:

"Es sind dies eben Dinge, die sich wirklich gegenwärtig nicht, ohne gegen das Postulat der Objektivität zu sündigen, mit wenigen Worten abtun lassen. Ein Blick auf Casparis Literaturverzeichnis, das mehr als ein halbes Tausend Abhandlungen umfasst, wird Ihnen zeigen, dass ich darin recht tue" (pp. 475-476).

In conclusion the reviewer is tempted further to quote the judgment of von Fürth respecting the duty of an investigator to correlate his own experiences so that they afford a logical summary of his undertaking. Thus in referring to the myriad of details published in recent years by London and his pupils on the physiology and chemistry of the digestive functions von Fürth remarks:

"Ich bin ehrlich genug, um offen einzugehen, dass ich mich einer Würdigung dieser ungeheuren Fülle von sicherlich sehr verdienstvollen Einzelbeobachtungen nicht gewachsen fühle. Eine solche wird wohl erst dann möglich sein, wenn London selbst sich einmal der Mühe unterzieht, dieselben im Zusammenhange kritisch zu verarbeiten und seine leitenden Gedanken, die auf so viele Publikationen verteilt sind, dass der Aussenstehende den Zusammenhang verlieren muss, hervorzuheben. Es ist dann zu hoffen, dass sich aus diesen und anderen Arbeiten, welche verwandten Zielen zustreben allmählich ein abgerundetes Bild des Eiweissabbaues im Darms in seinen einzelnen Phasen gestalten wird" (p. 71).

To those who wish to orient themselves in the changing aspects of physiological research, particularly its chemical manifestations, the lectures by von Fürth will surely serve as a stimulating guide. Books of this type are rare.

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*Alternating Currents and Alternating Current Machinery.* By D. C. and J. P. JACKSON. New York, The Macmillan Company, 1913. Pp. viii + 968, 521 text figures. Price, \$5.50.

This new edition of a well-known work furnishes one of the best general treatments on the subject of alternating currents, as did the first edition in 1896. Rewritten and expanded

to twice its former size, it forms a very complete and, on the whole, well-balanced treatise. The work is attractive, the style easy and the illustrations, many of them diagrammatic, are instructive. Descriptive and mathematical discussions are combined throughout, and examples from practice are used to illustrate theory.

Attempting to cover so much in a single volume assigns a formidable task to both author and reader. Although on the whole satisfactory, the treatment might to advantage have been made more systematic; the book would not have suffered by being more condensed. The chapters on synchronous machines (185 pages) and on transformers (155 pages) approach special treatises on these subjects. The latter would be improved by complete rearrangement, the discussion of mutual induction forming not so suitable an introduction to the transformer, in a book of this kind, as would a discussion of diagrams and equivalent transformer circuits that are discussed later in the chapter. The discussion of power and power factor is particularly satisfactory and complete.

That the authors omitted many historical footnotes seems unfortunate. Such notes not only serve to give credit where it may be due, but they make possible for the reader a more detailed study of special subjects than the limited description of any one text will permit. The footnotes retained (and these are not a few) prove their value. The authors refer in their preface to the intentional omission of many notes on the ground that they are unessential for undergraduates. But the scope of the book justifies no such limitation; its field is much wider than the undergraduate class-room. The book should find many readers whose undergraduate days have long since passed. The authors are to be thanked for its production.

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*Petrographisches Vademekum.* Second edition. By E. WEINSCHENK. Freiburg im Breisgau and Saint Louis, Mo., Herder Pub-

lishing Company. 1913. Pp. viii + 210; 1 plate; 101 figures in text. Price, ninety cents.

This little volume presents in an interesting manner those facts concerning rocks which are of interest to the student of general geology. The author has in mind a pocket manual which may be of service in the field. The treatment is from the standpoint of the macroscopic properties of rocks and is thoroughly modern. The book is well printed. The illustrations are excellent.

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### SPECIAL ARTICLES

#### THE CULTIVATION OF TISSUES FROM THE FROG

In a series of experiments on the culture *in vitro* of tissues of the frog it was found that several kinds of tissues show a marked outgrowth after being kept for a few days in lymph or plasma. Small pieces of the tissues were mounted according to the usual method in hanging drops of the culture medium and sealed with vaseline in hollow slides. Cells may remain alive under these conditions for several weeks.

Spleen, bone-marrow and pseudothyroid give rise to a fringe of outwandering cells resembling leucocytes which extend farther and farther into the surrounding medium. Larger connective tissue cells wander out later, and both types of cells exhibit amœboid changes. Small pieces of tissue may almost entirely disintegrate into wandering cells.

The epithelial cells of the skin extend generally as a broad thin sheet of tissue. The cells move out in contact with the cover slip or the lower surface of the drop. Individual cells of the epidermis may become isolated and creep out alone, but there is a marked tendency for the cells to keep together in a continuous membrane. In a previous paper on the movements of the ectodermic epithelium of amphibian larvæ<sup>1</sup> it was shown that the ectoderm cells actively creep out by an amœboid movement of

the very thin and transparent protoplasm of their free borders. The method by which sheets of epithelium extend in the adult frog is essentially the same as in the embryo or larva.

In several cases black pigment cells were seen to isolate themselves and wander out along the cover slip or lower surface film of the drop. In some cases, especially in the smaller pigment cells, the changes in form were fairly rapid. Pseudopods were thrust out and retracted very much as in the common amœba, and in some instances the cells were seen to migrate nearly across the field of the microscope. The processes of the pigment cells of the adult, unlike those of the larvæ, may be nearly transparent, and they usually are so when first formed; frequently, however, they are very soon invaded by pigment granules. Outwandering cells may show branching processes characteristic of the expanded melanophores of the frog's skin. The change in form of the pigmented mass within the cell is due in part to changes in the outline of the whole cell and in part to the flowing back and forth of pigment granules within the cell processes. There is a measure of truth, therefore, in both the rival theories of the changes of the chromatophores in the skin of the frog.

In some preparations the peritoneal epithelium wandered out in the form of a sheet of tissue considerably greater in area than the original preparation. For the most part the extension consisted of flattened cells arranged in a single layer and showing a hexagonal contour like the cells of the shed cuticle. Many of these cells were furnished with cilia which beat actively for two weeks. The ciliated cells frequently became amœboid and wandered free from the rest, sending out fine processes several times the original diameter of the cell. Sometimes the processes branched repeatedly. One would not suspect these cells to be derived from ciliated epithelium were it not for their tuft of beating cilia, and the fact that one can actually observe their transformations. Follicle cells of the testis may creep out and give the appearance of giant amœbæ.

Fuller details of the behavior of various

<sup>1</sup> Univ. of Calif. Pubs. Zool., 1913.

types of tissue cells will appear in later papers. Similar experiments were tried with the tissues of crayfishes and crabs with little result beyond keeping these cells alive for several weeks. The blood corpuscles of the crayfish were kept alive and active for three months.

S. J. HOLMES

NOTE ON THE ABSORPTION OF CALCIUM DURING  
THE MOLTING OF THE BLUE CRAB,  
*CALLINECTES SAPIDUS*

THE problem of molting in crabs has thus far been investigated, with one exception,<sup>1</sup> only from the morphological point of view.<sup>2</sup> The following observations bear on certain chemical phases of the process of hardening following normal molting in the common blue crab.

The crab hardens by the deposition of  $\text{CaCO}_3$  within the tissues of the soft shell. Has this Ca been absorbed and held in reserve during the period of preparation for molting,<sup>3</sup> or is it absorbed from the sea-water during the actual period of hardening? To test this matter, the following procedure was employed. Three pairs of crabs were chosen, each pair consisting of a recently shed individual and of a hard-shell individual of nearly the same size.<sup>4</sup> A comparison of the Ca content of the individuals of the same pair should throw light on the alternatives suggested. If the Ca content of the two members of each pair is equal, then the Ca must be absorbed before molting and held in reserve. If the Ca content of the hard specimen is very much larger than that of the soft, then the Ca must be absorbed after

<sup>1</sup> Irvine and Woodhead, *Proc. Roy. Soc. Edinb.*, Vol. 16, pp. 324-354, 1888-89.

<sup>2</sup> For a review of the literature on the natural history of molting in Crustacea, see Herrick, *Bull. U. S. Bureau of Fisheries*, Vol. XV., pp. 1-252, 1895. For this species of crab, see Hay, *App. Rep. U. S. Comm. Fish.*, pp. 395-413, 1904.

<sup>3</sup> Cf. Smith, *Quart. Journ. Microsc. Sci.*, Vol. 59, p. 272, 1913.

<sup>4</sup> These were collected at the Beaufort, N. C., station of the U. S. Bureau of Fisheries. The writer is indebted to Dr. H. M. Smith, the commissioner, for the privilege of staying at the station.

molting. Furthermore, if the first alternative is the true one, the Ca content of a crab in the act of casting its shell should be much greater than that of a normal hard crab. If, however, they have the same Ca content, then the second alternative is indicated.

Each crab was ashed separately, and the Ca in the ash determined by precipitating it as the oxalate, igniting and weighing as the oxide. The results of the analyses are indicated in the table. In each pair the hard-shell specimen contains about twenty times the amount of Ca contained in the soft one. Also, Crab No. 9, which was in the act of casting its shell, has a Ca content comparable to that of a normal hard individual.

This shows clearly that the Ca used by the soft-shell crab for the purpose of hardening its new shell is not present at the time of the molt, but is absorbed from the sea-water during the hardening.

The mechanism by means of which a molting crab is enabled to absorb such abnormally large quantities of Ca is at present obscure, and in view of the meager data at hand, a discussion of this problem is best postponed until more work shall have been done.

TABLE

Crab No.	Condition	Width, Cm.	Weight, Gm.	Weight, Ca, Gm.	Ca Content, Per Cent.
6	soft	8.3	37.20	0.0720	0.19
11	hard	8.3	34.54	1.845	5.34
3	soft	9.7	56.53	0.1468	0.26
7	hard	9.5	61.62	2.963	4.81
13	soft	10.5	70.00	0.2197	0.31
12	hard	11.0	70.90	3.617	5.17
8	hard	8.7	54.75	2.861	5.22
9	molting	8.5 <sup>5</sup>	67.93	2.520	3.72

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<sup>5</sup> The width of the new shell was 9.8 cm. The per cent. of Ca in this specimen is low because the molting crab weighed more than an ordinary 8.5 cm. crab, and also because the old shell had two legs missing, which were being regenerated. The actual weight of Ca, however, is very close to that of a normal hard crab.

## SOCIETIES AND ACADEMIES

## THE BOTANICAL SOCIETY OF WASHINGTON

THE ninety-second regular meeting of the Botanical Society was held at the Powhatan Hotel on Tuesday evening, December 2, 1913, at which a dinner and special program were given in honor of the seventieth birthday of Dr. Edward Lee Greene, the president, Dr. C. L. Shear, presiding.

Mr. John H. Parker was elected to membership. The program was as follows:

*Personal Experiences:* MR. FREDERICK V. COVILLE.

Mr. Coville related incidents in connection with his first meeting with Dr. Greene at the Madison Botanical Congress in 1893, and expressed a high appreciation of his work, particularly of his "Landmarks of Botanical History."

*Berkeleyan Days:* MR. V. K. CHESTNUT.

Mr. Chestnut spoke of his student days at the University of California and of the inspiration received from Dr. Greene by his botanical students.

*Botanical Writings:* PROFESSOR A. S. HITCHCOCK.

Professor Hitchcock recalled at the International Botanical Congress in 1893 at Madison an incident as illustrating Dr. Greene's taxonomic methods. One day he showed to a group of interested botanists a difference between the two common species of foxtail grass, *Chætochloa viridis* and *C. glauca*. He pointed out that the blades of the first were straight, while those of the second were twisted into a partial spiral. He stated that the reason why these differences were not given in the books was partly from tradition, it not being considered good form to depart very widely from the system of basing differences on the characters of the flowers or fruit; and partly for the reason that the botanists who wrote the books were not sufficiently familiar with the growing plants.

Dr. Greene's first taxonomic paper<sup>1</sup> was entitled "Notes on Certain Silkweeds."

Professor Hitchcock stated that the value of Dr. Greene's contributions to botany or his influence upon botanical thought did not rest solely upon the large number of new species he had described, but that he had studied many groups of plants, had revised many genera, discussed relationships and set on their feet, as it were, species and genera of early authors that had been relegated to oblivion by those that followed.

*Reminiscences:* MR. IVAR TIDESTROM.

Mr. Tidestrom stated that Dr. Greene began his

botanical career before the Civil War. In 1862, while a young soldier of nineteen in the army of General Grant, he collected a number of plants from the battlefield of Fort Donelson. This collection he sent to his mother, who had them mounted in an album and exhibited at a fair of the Sanitary Commission at Chicago. The collection was sold for \$50 and the money applied for the relief of sick and wounded soldiers.

Dr. Greene, after all the jealousies and personalities have disappeared, should be remembered not for the many species he has diagnosed, but for his unchallenged devotion to botany, for the gathering of an herbarium of nearly 100,000 specimens, and a library of some 3,600 volumes.

Mr. Tidestrom then stated that a few botanists knew the plants of their regions better than any one else, but challenged any one to produce a man who could approach Dr. Greene in the knowledge of plants of the vast empire lying between New York and San Francisco.

*Rocky Mountain Flora:* PROFESSOR AVEN NELSON.

"I count it singularly fortunate that this interesting event should have happened to occur during my short stay in Washington. I feel doubly delighted in that I am permitted not only to express my personal pleasure by my presence but also to voice for others, as well as myself, the high regard with which we greet the man whom to-night we delight to honor.

"The third part of a great continent, the interior west; the Rocky Mountain region of America, brings its greetings of good-will and love to him to whom its floral wealth is an open book. To every working botanist in this vast field the name of our guest is a familiar word. It matters not whether he be devoted to the technical or the applied phases of the subject at some point in his work every botanist finds the taxonomist's services required. I therefore presume to speak for my colleagues in every experiment station, college and university from Mexico to Manitoba and westward to the sea; and not for my colleagues only but for every amateur who loves the wayside flower for its own sake, as well as for that larger public that loves the woods and fields for their beauty and for their bountiful products. These all send greetings and grateful acknowledgment of the help and pleasure conferred upon them.

"For more than forty years Dr. Greene has loved the plants of the west with a love born of sympathetic, first-hand companionship. To the seemingly barren saline deserts, the chaparral-covered hills, the grassy parks, the dense forests and

<sup>1</sup> Bot. Gaz., 5: 64, 1880.

the alpine heights he is no stranger. Could he leave his more serious tasks long enough he would hasten to greet the floral friends of that earlier day as well as to renew his fatherly interest in the hundreds of plant children of his maturer years. When Edward L. Greene first began tramping over the plains, racing through the valleys or eagerly climbing the unknown heights of Colorado and Wyoming your speaker was still a small boy on an Iowa brush farm. Little did I then think as, plowing corn with old Dobbin, I stopped to pick the cockle-burs from between the toes of my bare feet, that some day I too should be vitally interested in strange and beautiful plants in a, to me, unknown land. But to my friend and teacher (for such I count him in the largest and best sense) they had even then become of absorbing interest. He was gathering specimens in order that he might know the splendid treasures that greeted him at every turn.

"This man, a missionary, in rounding up and corralling for a life of decency and usefulness, the cowboys of the then 'wild and woolly' west, traveled far and wide. He sought men in the open marts and plants in their secluded nooks. The offerings he brought back to the altar were both acceptable, but may it not be that, reversing the order of that primal day, the flowers and fruits of the field yielded more acceptable incense than the firstlings of the flock? I imagine that as the years sped by, he more and more taught men of the wisdom and goodness of the Creator through the marvelous adaptations and beauty of the flora.

"As preaching is teaching and teaching is preaching, so the transition to the professor's chair was an easy one. During the years as they were slipping along, his field of observation widened, his knowledge of plants and their characters deepened, and his theory of the principles of classification ripened. Thus he has gradually been brought into the zenith of his power. Plants from the east and the west, from the north and the south have passed under his observation, but no field has received such discriminating scrutiny as the Rocky Mountains. He knows this field piecemeal; he knows it as a whole.

"And what a flora it is! Some of the states have singly almost as many species as the whole empire east of the Missouri. Environments of greatest diversity as to soil character, water content, heat and light factors, and all these interacting upon each other as they are successively modified by altitudes varying from near sea-level to

alpine heights have given a flora that is marvelous in its complexity. Near relatives of species well fixed under normal and uniform conditions seem here to have been thrown into such a state of 'wobble' that new forms appear to have arisen over night. Multitudinous variations, more or less well fixed, crowd upon each other everywhere. Decry species-making as you will, in the west nature seems to have been working overtime at this very thing and in a very abandon of joy. Then why should not her greater children who have the eyes to see and the mind with which to discern read and record the results?

"In this work Dr. Greene holds and has long held an enviable place. The intimate field knowledge of the earlier decades of his career forms the basis for the discriminating work that is now the marvel and the despair of those of us who have drunk less deeply at the Pierian spring. As we note his facile pen, the classical clearness, brevity and exactness of his diction, the rapier-like thrusts of his criticism, that cut but carry no toxins, one can not help feeling that for a botanist to know little Latin and less Greek is a misfortune—nay almost a crime. Sometimes such an one must wonder whether

'Twere better to have loved and lost  
Than never to have loved at all.'

"For our crass ignorance he has scourged us again and again. Though the lash may 'cut to the quick' yet by these stripes are we being healed. They were never meant to drive a man from the field simply because he is a beginner. Dr. Greene always has a word of encouragement for him who enters Flora's temple to worship in the right spirit. He manifests no desire to preempt the place and the 'divine right' of the king is not engraved upon his banner.

"That other eyes fail to see the things that he sees; that even from similar observations different judgments are formed and different conclusions drawn are not to him of such serious moment that each may not go on with friendship for the other, each cultivating his own wee bit of the ever-widening field. To live honestly with nature, to deal justly with your fellow worker, to love mercy is a creed to which we can all subscribe. Were this not true and generally practised, few there be that would dare to follow nature in her devious paths. No single mind can grasp all her secrets. Truth is always truth but she is many-sided. No one pair of eyes can view her from all sides at any one time. A partial truth may in effect, there-

fore, be a complete error, hence error often rides in honesty's carriage.

"Differ as we may as to what constitutes a species, the object of us all is to know plants and to help others to know them. To know and to use plants that they may contribute to our wealth is well; to know them that they may contribute to the health and pleasure of body and mind is better; to know them that we may read a few of God's thoughts after him and thus enrich our souls is best. He who puts us in closer touch with the Creator through his creations is doing a man's work in God's world.

"In conclusion let me say that we have not met to place wreaths upon the brow of our distinguished coworker. There are none which his splendid achievements in systematic, historical and philosophical botany have not already won. His head is already resplendent with a silvery crown. The white is not the frost of many winters. It is the incarnation of the spirit of beauty and service that finds its best expression in spring-time flowers and autumnal fruitage. New radiance is gained at every passing milestone. May there still be many of them. May all the years bring seed-time and harvest in which the fruitage shall be as abundant as in the seven years typified by the seven well-favored, fat-fleshed kine that Pharaoh saw in his dream—fruitage even unto well-filled ears upon every stalk. May no lean kine nor blasted ears devour any of the beautiful years in the life of him who is seventy years young to-night."

Response: DR. GREENE.

Dr. Greene, after expressing his appreciation of the honor accorded him by the Botanical Society, related a few interesting incidents connected with his life.

His first vague impressions were connected with flowers, of roses and geraniums in his mother's window, at the early age of a year and a half. When he was a boy eight years of age the people in the district in which he lived frequently would go to him to find out the names of plants and where certain rare ones could be found.

One of the most interesting incidents that he related was a journey on foot from San Diego, California, to Santa Fé, New Mexico, in the year 1877, when there was not a line of railroad in all southern California, and only a stage line from San Diego to Santa Fé. Before starting out on this venturesome journey he visited the old cemetery at the San Diego Mission. He said that he

had always loved old graveyards and cloudy weather, and that music with a minor strain appealed to him especially. Among the black crosses in the graveyard was a white marble slab bearing the inscription "Edward L. Greene," with the dates of his birth and death. He who had borne this name had died at Dr. Greene's own age at that time. Dr. Greene wondered if this could be an omen, and whether it meant that he was starting out upon his last journey.

The country from San Diego to Yuma was a difficult one, and he carried only his portfolio and a few changes of socks, sending his money ahead in post office orders. At Yuma he met with a cordial reception, and was invited to hold religious services the next morning after his arrival in a public hall. He remained there over Sunday and Monday. Afterwards he saw in the little newspaper published at Yuma the following notice, concise and to the point in the expressive language of the frontier: "Last Saturday evening the Reverend Edward L. Greene reached Yuma on foot from San Diego. On Sunday morning he preached an excellent sermon to a fair congregation, and another in the evening to a large one. On Tuesday morning, refusing all offers of transportation or financial help, he continued his way eastward. This is solid pluck in big chunks. Boys, get acquainted with him; you will like him, and will find that he is no chicken-eating bummer."

The first Indians he encountered on this journey were standing in a clump of *Covillea* bushes looking at him curiously. Being rather apprehensive, he walked straight to them and fearlessly seized the arms of one of them as though inviting him to wrestle. This Indian, a very tall young man of splendid physique, noticed a ring on Dr. Greene's finger, a ring of red Australian gold. He asked if it were real gold. Dr. Greene took it off his finger and handed it to him, thinking that he would never see it again, but the Indian, after tossing it up and catching it once or twice as if to test its weight, handed the ring back to him.

Dr. Greene reached Silver City in April and remained there three months collecting plants in all directions within a radius of several miles. The only botanist who had preceded him in this locality was Dr. Charles Wright, whose collections had made it classic ground. On one excursion Dr. Greene discovered a beautiful valley about forty miles from Silver City. It was most picturesque and contained cold and hot springs. When he

returned to the nearest settlement he described the marvelous beauty of this valley. A short while afterwards some of his friends, attracted to the valley by his description, camped in the same spot. They were all murdered there by Indians.

On his journey from Silver City to Santa Fé Dr. Greene was overtaken by a man on horseback, an agreeable-looking fellow, dressed in a business suit. He carried two pistols and a rifle slung over his shoulder. At the first stage station the two travelers stayed over night. The stranger seemed to be interested in Dr. Greene and his work. He was a fair-spoken, likable man, with polished manners. Dr. Greene noticed that he carried great rolls of greenbacks bulging from his pockets. Dr. Greene carried about 15 or 20 dollars of his own in a bag swung over his back. The two travelers proceeded onward the next day together. On the road the stranger asked Dr. Greene if he had ever encountered any bandits or outlaws, and said that he himself had spent many days with them in their mountain camps, and that as a rule they were good fellows to be with. The two men parted good friends. Afterwards Dr. Greene learned that his late companion was the leader of a well-known band of robbers.

In 1870 while botanizing on the slope of a snowy range west of Denver in a part of the country not yet settled Dr. Greene started up an inviting valley. After proceeding about a quarter of a mile he saw an Indian on horseback, then another, and another, until there must have been at least 150 Indians in the valley. One, who seemed to be their chief, squared his horse across the path and made signs that he wanted to examine the bag which Dr. Greene carried. When he opened the portfolio and saw nothing but plants he exclaimed, "Ugh! Medicine Man." He then asked Dr. Greene's name, and in return said that his own name was Colorao. This was the name of a notorious chief of the Utes, who was much feared by the whites. Less than three years afterwards this man murdered the entire agency to which the Utes belonged.

In conclusion Dr. Greene again expressed his appreciation of the honor accorded him and of the kind things which had been said regarding the matter of his life's work.

The society also arranged to present Dr. Greene with a book plate as soon as he should approve designs to be submitted by artists.

P. L. RICKER,  
*Corresponding Secretary*

#### ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

THE twenty-first meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held at the State Normal College on November 29, 1913. The following program was given:

10 o'clock

Appointment and reports of committees.

"Are Particular Abilities Necessary for the Pupil to Gain an Understanding of the Elementary and Secondary Mathematics as Usually Given at the Present Time," by Maurice J. Babb and Charles F. Wheelock.

Discussion.

"A Comparison at Equal School Ages of the Attainments in Mathematics of the European and American Schoolboy with a Consideration of Causes and Remedies," by James C. Brown.

Discussion.

2 o'clock

"Mathematics as a Means to Culture and Discipline," by Albert Duncan Yocum.

Discussion.

"The Use of the Question in the Classroom," by Romiett Stevens.

Discussion.

The election of officers resulted as follows:

*President:* Eugene R. Smith, Park School, Baltimore, Md.

*Vice-president:* Herbert E. Hawkes, Columbia University, New York City.

*Secretary:* Howard F. Hart, Montclair High School, Montclair, N. J.

*Treasurer:* E. D. Fitch, De Lancey School, Philadelphia, Pa.

*Council Members:* Lao. G. Simons, City Normal College, New York City; W. H. Sherk, La Fayette High School, Buffalo, N. Y.

The next meeting will probably be held at New York City in February.

H. F. HART,  
*Secretary*

#### PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA, MATHEMATICAL AND SCIENTIFIC SECTION

THE second meeting of the session 1913-14 was held November 24. Professor Francis H. Smith presented a paper on "The Foucault Pendulum, and its Possibilities as a Convenient Lecture-room Experiment." A form of apparatus capable of quantitative demonstration within the time of 3 minutes was treated.

L. G. HOXTON,  
*Secretary*